MANAGING TENSIONS: AGILE AND SUSTAINABLE STRATEGIES IN PROJECT PORTFOLIO MANAGEMENT

vom Fachbereich Rechts- und Wirtschaftswissenschaften
der Technischen Universität Darmstadt

zur Erlangung des akademischen Grades
Doctor rerum politicarum (Dr. rer. pol.)
genehmigte

Dissertation
von Jadena Bechtel

Erstgutachter: Prof. Dr. Alexander Kock

Zweitgutachterin: Prof. Dr. Carolin Bock

Darmstadt, 2024

Bechtel, Jadena: Managing tensions: agile and sustainable strategies in project portfolio management

Darmstadt, Technische Universität Darmstadt,
Jahr der Veröffentlichung der Dissertation auf TUprints: 2024

Tag der mündlichen Prüfung: 08.07.2024

Danksagung

Zuerst möchte ich mich bei meiner akademischen Familie bedanken. Ein herzliches Dankeschön an Alex für die Betreuung und die großartige Zusammenarbeit in den letzten Jahren. Deine ständige Beteiligung an unseren Studien und Veröffentlichungen war für mich von unschätzbarem Wert und keineswegs selbstverständlich.

Carolin, ich danke dir für die inspirierenden Diskussionen während unserer gemeinsamen Forschungsseminare und für die Übernahme des Korreferats.

Ein Dank geht auch an meine geschätzten Kollegen und akademischen Brüder, die mich begleitet haben: Tim, Christian R., Carsten, und Christian T. Durch euch wurden die Konferenzen zu unvergesslichen Erlebnissen.

Des Weiteren möchte ich mich bei meinem privaten Umfeld bedanken. Meinen Eltern, Alwine und Thomas, gilt ein besonderer Dank für ihre Unterstützung meiner Träume und Ziele sowie für ihren unerschütterlichen Glauben an mich.

Patrick, deine Geduld und dein Verständnis haben mich in schwierigen Zeiten getragen. Du gibst mir stets das Gefühl, dass ich alles schaffen kann, auch wenn dafür manchmal Pausen nötig sind.

Ein weiterer Dank gebührt meinen Großeltern, Karin und Gerd, sowie meinem Bruder Marco. Auch wenn ihr nicht immer verstanden habt, was ich da getan habe, so habt ihr dennoch immer an mich geglaubt.

Danke auch an meine erweiterte Familie, Ann-Kathrin, Irmhild und Jörn. Ihr drei habt selbst schon akademische Wege eingeschlagen und standet mir mit Rat und Tat zur Seite.

Schließlich möchte ich meinen engen Freunden danken, die mir während all der Jahre stets mit einem offenen Ohr zur Seite standen: Sabrina, Simon, Nadine, Philipp, Clara, Patrick G. und Janes. Ich bin froh, euch in meinem Leben zu haben.

Zusammenfassung

Unternehmen sehen sich in der heutigen schnelllebigen und komplexen Geschäftswelt regelmäßig mit Spannungen konfrontiert. Im Projektportfoliomanagement führt das Zusammenspiel verschiedener Strategien und die sich wandelnden Anforderungen oft zu hoher Komplexität, die die effektive Auswahl und Überwachung von Projekten erschwert. Die Dissertation befasst sich daher damit, wie Projektportfoliomanager und Projektleitende Spannungen bewältigen können, die durch die Implementierung agiler Werte und Nachhaltigkeit entstehen, um innovativ und letztlich erfolgreich zu sein. Bezüglich agiler Werte zeige ich empirisch, dass agile Praktiken zwar positive Ergebnisse wie eine verbesserte Zusammenarbeit auf Projektebene erzielen, ihre Integration in traditionell geführte Projektportfolios jedoch Herausforderungen mit sich bringt. Zudem belege ich, dass dynamische Fähigkeiten eine wichtige Voraussetzung für Portfolioagilität darstellen und indirekt zum Erfolg des Portfolios beitragen. Weiterhin untersucht die Dissertation den positiven Einfluss einer Nachhaltigkeitsorientierung auf den Innovationsgrad eines Projektportfolios. Trotz der anerkannten Vorteile von Nachhaltigkeitsstrategien kann ihre Integration paradoxe Spannungen mit bestehenden Wettbewerbsstrategien hervorrufen, deren Management einen passenden Kontext erfordert, um das Innovationspotenzial voll auszuschöpfen. Die Dissertation analysiert auch die Rolle von Reallaboren bei der Förderung von Innovationen und unterstreicht die Notwendigkeit von Längsschnittstudien, um deren Entstehung und mögliche Agglomerationseffekte zu verstehen. Durch die Auseinandersetzung mit diesen Forschungslücken zielt die Dissertation darauf ab, Einblicke und praktische Strategien für Manager zu bieten, um die Komplexitäten der Implementierung agiler und nachhaltiger Werte im Projekt- und Portfoliomanagement zu bewältigen. Zudem wird die Bedeutung des Kontextes von Projekten und Portfolios hervorgehoben.

Abstract

Organizations grapple with tensions regularly in today's rapidly evolving and intricate business landscape. Within project portfolio management, the interplay of diverse strategies and changing requirements often gives rise to complexities that impede effective project selection and monitoring. Thus, this dissertation addresses how managers of projects and project portfolios can manage tensions that arise from implementing agile values and sustainability to become innovative and, eventually, successful. Regarding agile values, I empirically reveal that while agile practices have demonstrated positive outcomes like teamwork quality at the project level, their integration into traditional project portfolios presents challenges, necessitating a deeper understanding of how agile projects behave within such environments. Further, I demonstrate that dynamic capabilities constitute a relevant antecedent to portfolio agility and indirectly contribute to portfolio success. Furthermore, this dissertation explores the positive impact of sustainability orientation on innovation within project portfolios. Despite the recognized benefits of sustainability strategies, their integration may create paradoxical tensions with existing competitive strategies, necessitating effective management through the proper context to harness potential innovation. The dissertation also investigates the role of living labs in fostering innovation within project portfolios, emphasizing the need for longitudinal research to understand their emergence and potential agglomeration effects. Through addressing these research gaps, this dissertation aims to provide insights and practical strategies for managers to navigate the complexities of implementing agile and sustainable values within project and portfolio management contexts. It further highlights the importance of the context of projects and portfolios.

Keywords: project portfolio management, paradoxical tensions, agile projects, dynamic capabilities, living labs, sustainability orientation

Table of Content

List of Figures ..... **viii**

List of Tables ..... **ix**

Chapter 1 Introduction **1**

1.1 Motivation 1

1.2 Research Gap and Research Questions 3

1.3 Conceptual Background 6

1.3.1 Paradox Theory 6

1.3.2 Project Portfolio Management 7

1.4 Overview of Dissertation 8

Chapter 2 Research Study A: Agile Projects in Non-Agile Portfolios: How Project Portfolio Contingencies Constrain Agile Projects' Teamwork Quality **19**

2.1 Introduction 20

2.2 Conceptual Background 22

2.2.1 Teamwork in Projects 22

2.2.2 Agile Project Management and Agile Project Teams 23

2.2.3 Project Portfolio Management as Organizational Context for Projects 24

2.3 Hypotheses 26

2.3.1 Agile Practices and Teamwork Quality 26

2.3.2 TWQ as a mediator of agile practices on project success 27

2.3.3 The Moderating Effects of Portfolio Management 27

2.4 Method 31

2.4.1 Sample 31

2.4.2 Measurement 32

2.5 Results 39

2.6 Discussion 43

2.6.1 Theoretical Implications 43

2.6.2 Managerial Implications 45

2.6.3 Limitations and Future Research 45

Chapter 3 Research Study B: The Interplay between Dynamic Capabilities' Dimensions and Their Relationship to Project Portfolio Agility and Success **47**

3.1 Introduction 48

3.2 Theoretical Framework 50

3.2.1 Dynamic capabilities and their contribution to performance 50

3.2.2 PPM as a dynamic capability 51

3.2.3 Project Portfolio Agility 52

3.3 Hypotheses....53
3.3.1 Overview....53
3.3.2 Agility and Project Portfolio Success....54
3.3.3 Dynamic Capabilities' Role for Portfolio Agility....55
3.4 Methodology....56
3.4.1 Sample....56
3.4.2 Measurement....58
3.5 Results....63
3.6 Discussion....67
3.7 Conclusions....69
3.7.1 Theoretical Implications....69
3.7.2 Managerial Implications....70
3.7.3 Limitations and Future Research....71

Chapter 4 Research Study C: The Relevance of Urban Agglomeration Micro-Foundations for the Emergence of Innovation in Living Labs: A Qualitative Field Study....73
4.1 Introduction....74
4.2 Theoretical Background....75
4.2.1 Living Labs....75
4.2.2 Innovation and Micro-Foundations for Urban Agglomeration....76
4.3 Method....78
4.3.1 Research Context....78
4.3.2 Research Design and Data Collection....79
4.4 Results....82
4.4.1 Sharing in Living Labs....84
4.4.2 Matching in Living Labs....85
4.4.3 Learning in Living Labs....87
4.5 Discussion and Conclusion....89
4.5.1 Theoretical Implications....90
4.5.2 Managerial Implications....90
4.5.3 Limitations and Future Research....91

Chapter 5 Research Study D: The influence of sustainability orientation in innovation portfolios....93
5.1 Introduction....94
5.2 Theoretical Framework....96
5.2.1 Innovation Portfolio Management and Success....96
5.2.2 Strategic Orientations and Sustainability Orientation....97
5.2.3 Concepts of Sustainability in Innovation Portfolios....99

5.3 Hypothesis 100
5.3.1 Overview 100
5.3.2 The Mediating Role of Portfolio Innovativeness 100
5.4 Methodology 102
5.4.1 Sample 102
5.4.2 Measurement 103
5.5 Analysis and Results 107
5.5.1 Measurement Model Results 107
5.5.2 Structural Model Results 108
5.5.3 Robustness Tests 109
5.6 Discussion 109
5.6.1 Theoretical Implications 111
5.6.2 Managerial Implications 112
5.6.3 Limitations and Future Research 113

Chapter 6 Research Study E: Do sustainability tensions harm or benefit innovation portfolios? A paradoxical perspective 115
6.1 Introduction 116
6.2 Theoretical Framework 118
6.2.1 Tensions and Paradox Theory 118
6.2.2 Paradoxical Tensions in Sustainability 119
6.2.3 Innovation Portfolio Management and its Context 120
6.3 Hypotheses 122
6.3.1 Entrepreneurial Orientation as Boundary toward Managing Sustainability Tensions 122
6.3.2 Innovation Climate Fostering Dynamics toward Managing Sustainability Tensions .123
6.4 Methodology 125
6.4.1 Sample 125
6.4.2 Measurement 126
6.5 Results 130
6.6 Discussion 133
6.6.1 Theoretical Implications 133
6.6.2 Managerial Implications 135
6.6.3 Limitations and Future Research 135

Chapter 7 Discussion 137
7.1 Conclusion 137
7.2 Implications for Research 138
7.3 Implications for Practice 140
7.4 Future Research 142

References ..... **I**

Declaration of Authorship ..... **XXII**

List of Figures

Figure 1. Conceptual model (Research Study A) 31
Figure 2. (Left) Marginal effects of Agile Practice Intensity on TWQ in respect of different levels of business case existence, strategic clarity, and operational control (thin lines represent a 90% confidence band); (Right) Marginal effects of Agile Practice Intensity on Project Success (dashed lines represent a 90% confidence band) (Research Study A) 42
Figure 3. Conceptual framework (Research Study B) 54
Figure 4. Results of structural equation model. Second-order modeling (Research Study B) 64
Figure 5. Simple slopes (Research Study B) 67
Figure 6. Micro-foundations of agglomeration effects before and after the project started in the living lab (Research Study C) 83
Figure 7. Research model (Research Study D) 100
Figure 8. Results of the Structural Model. (Research Study D) 109
Figure 9. Conceptual Framework. (Research Study E) 122
Figure 10. Left side: Marginal effects of sustainability tensions on portfolio innovativeness for different levels of innovation climate or entrepreneurial orientation (grey lines represent 90% confidence bands). Right side: Simple slopes of the relationship between sustainability tensions and portfolio innovativeness with high/low innovation climate or entrepreneurial orientation. (Research Study E) 133

List of Tables

Table 1. Dissertation's studies overview.....10
Table 2. Sample characteristics (Research study A) 32
Table 3. Measurement (Research Study A).....33
Table 4. Correlations and descriptives (Research Study A).....38
Table 5. Regression results (Research study A) 41
Table 6. Sample characteristics (Research Study B).....58
Table 7. Survey Items (Research study B) 59
Table 8. Descriptives and correlations (Research Study B) 63
Table 9. Regression results (Research study B) 66
Table 10. Interviewee background information (Research Study C) 81
Table 11. Sample Structure (Research Study C) 82
Table 12. Sample characteristics. (Research Study D).....103
Table 13. Descriptives and Correlations. (Research Study D) 106
Table 14. Survey Items. (Research Study D) 106
Table 15. Sample Characteristics. (Research Study E) 125
Table 16. Descriptives and Correlations. (Research Study E).....128
Table 17. Survey Items - Hypotheses variables (Research Study E) 128
Table 18. Survey Items - Control Variables (Research Study E).....130
Table 19. Regression Results. (Research Study E).....132

Chapter 1 Introduction

1.1 Motivation

Firms and their decision-makers encounter contradictions every day due to the increasing complexity of the modern business world (Smith, 2014; Schad et al., 2016). For example, rapidly changing framework conditions let companies face the challenge of balancing long-term goals with short-term responsiveness (Slawinski and Bansal, 2015; Putnam et al., 2016). Accordingly, management research extensively addresses the multifaceted phenomenon of paradoxes (Smith and Lewis, 2011; Schad et al., 2016). Paradoxes are a "persistent contradiction between interdependent elements" (Schad et al., 2016, p. 10). They are a defining feature of a complex environment, with its complexity perpetually on the rise (Lewis and Smith, 2022). Especially today, we are facing multiple crises, such as health crises and the grand challenges "characterized by political instability, economic volatility, and societal upheaval" (George et al., 2016, p. 1880). Thus, companies will frequently encounter new challenges and must respond to them. As demonstrated by the effects of the COVID-19 pandemic on employees, companies were forced to find solutions for exhausted remote working employees (Chong et al., 2020). These areas are not directly related to daily business but can impact the company's success if not considered. Another example is sustainability. It became an important and, in some cases, mandatory driver of developing new company strategies due to governmental regulations (Kassinis and Vafeas, 2006). Introducing a sustainability strategy may initially present challenges for firms because of conflicting requirements (Hahn et al., 2015). However, if managed correctly, it can lead to innovative ideas, such as resource conservation (Hengst et al., 2020; Hoogendoorn et al., 2020). Paradox theory suggests that contradictions may not always be a disadvantage for companies but rather a challenge that can inspire innovation (March, 1991; Tushman and O'Reilly, 1996). This volatile and uncertain environment will impact the company's market presence and other areas of its operations, both internally and externally. It requires careful decision-making, making strategy clarity and execution more critical than ever (Smith, 2014).

Every company's strategy must result in operational measures that some companies implement through projects. Companies' project portfolios aim to realize their strategy (Killen et al., 2012). A project portfolio is effective if it reflects the firm's strategy, its projects are well-balanced, and its overall value is maximized (Martinsuo and Lehtonen, 2007). Project portfolio management is a decision-making process of prioritizing and selecting suitable projects that align with a company's strategy (Cooper et al., 2001; Kester et al., 2011; Martinsuo, 2013). It translates a company's strategy into operational projects under consideration of a company's external environment (Meskendahl, 2010; Kopmann et al., 2017). The strategic orientation of firms plays a pivotal role in influencing the decision-making processes of portfolios (Spanjol et al., 2012). Previous research has shown that the composition and

performance of a portfolio depend on strategic orientations, particularly on sharpening decision-makers attention towards the dominant strategic orientation (Salomo et al., 2008; Talke et al., 2011; Kock and Gemünden, 2020; Kaufmann et al., 2021). Strategic orientations exert a particularly pronounced influence on decision-making within innovation portfolios operating in environments characterized by high levels of uncertainty. However, external factors require companies to adjust their strategies or introduce new ones, affecting project selection (Kester et al., 2014). Here, tensions between strategies or strategic orientations may arise.

Especially, tensions may arise when implementing a sustainability strategy. Sustainability has become an inevitable topic organizations need to consider. Regulations, competitors, and customers drive organizations to adopt sustainability strategies and become more sustainability-oriented, thereby adding complexity to decision-making (Soderstrom and Weber, 2019; Hengst et al., 2020; Klein et al., 2021). A sustainability strategy differs significantly from a competitive strategy because it does not necessarily focus on financial success (Gatignon and Xuereb, 1997). Instead, it focuses on preserving resources, employees, and the company, prioritizing long-term viability over short-term gains. Further, governmental bodies have recently invested in sustainability measures to incentivize companies (Lindberg et al., 2019; Krieger and Zipperer, 2022). To integrate sustainability into their business practices, companies often collaborate with universities or participate in open innovation projects to leverage government investments (Fuglsang and Hansen, 2022). The project's success depends on representing one's interests while establishing good cooperation between partners. Tensions may arise due to differences in partner characteristics and the local nature of some projects (Nevens et al., 2013; McCrory et al., 2020).

In addition to strategy implementation, project portfolios can offer companies a competitive advantage if they can quickly and flexibly adapt to today's complex environmental conditions (Kock and Gemünden, 2016; Roth et al., 2019; Martinsuo and Geraldi, 2020). Therefore, agility is a crucial success factor at the portfolio level (Kester et al., 2014). However, portfolio management still faces the challenge of being agile due to companies seeking to develop new innovative opportunities while keeping existing businesses alive (Hoffmann et al., 2020; Muruganandan et al., 2022). This situation may cause conflicts between projects because resources are redirected from one project (e.g., current business operations) to another (e.g., new opportunity) in the short term (Kock and Gemünden, 2016).

On the project level, companies try new methods, such as agile practices, to deal with complexities and flexibly react to environmental changes (Stettina and Horz, 2015; Sweetman and Conboy, 2018). Agile practices are not a capability or behavioral construct, such as agility at the portfolio level, but rather a set of concrete practices and values. Agile practices involve obtaining regular customer feedback, working in iterative cycles, and focusing on minimum viable products (Dyba and Dingsoyr, 2008; Bianchi et al., 2020). Agile practices originated in software development but have also been applied to

portfolios in recent years (i.e., scaled agile practices) (Leffingwell, 2010). Agility may result from agile practices but is not limited to them (Kaufmann et al., 2020). Introducing agile practices stands in contrast with classic project management in some aspects. These various requirements can sometimes conflict at the portfolio level, where it is necessary to oversee all projects (Sweetman and Conboy, 2018).

In summary, project portfolio management is a valuable capability for decision-makers. Still, tensions are common during project selection and monitoring, particularly in today's complex environment. Companies must, therefore, regularly question and adapt their strategies to remain competitive in constantly changing environmental conditions. Additionally, portfolio management should be able to flexibly adjust the framework conditions of their projects and portfolios. This dissertation examines tensions that arise from different strategies and changing framework conditions in portfolios and how to manage them to ensure long-term success.

1.2 Research Gap and Research Questions

In the following section, I will separately identify the research gaps for agility and sustainability. Agility allows portfolios to adapt their resources flexibly to changing circumstances, such as customer needs (Kester et al., 2011). Portfolio management should establish conditions to implement agility and facilitate adaptive behavior successfully. One concept that supports adaptive behavior is dynamic capabilities (Teece et al., 1997; Helfat et al., 2009; Wilden et al., 2013; Schilke, 2014; Fainshmidt et al., 2016). Dynamic capabilities refer to an organization's ability to sense, seize, and reconfigure in response to environmental changes, facilitating innovation and adaptation (Teece, 2007). Scholars have recognized project portfolio management as a dynamic capability (Killen and Hunt, 2010; Petit, 2012; Kock and Gemünden, 2016) but did not directly operationalize them and rely on conceptual or qualitative studies (Killen et al., 2012; Petit, 2012; Daniel et al., 2014; Hoffmann et al., 2020). Furthermore, various operationalizations for dynamic capabilities hinder the comparability between studies (Tanriverdi and Venkatraman, 2005; Schilke, 2014). Therefore, it is necessary to operationalize the individual micro-foundations of dynamic capabilities and their interrelationships (Schilke et al., 2018). Further, the literature on antecedents for agility in project portfolio management is limited (Kock and Gemünden, 2016).

On a project level, agile practices became prominent to improve performance outcomes, especially customer satisfaction and time to market (Lee and Xia, 2010; Serrador and Pinto, 2015; Bianchi et al., 2020; Drury-Grogan, 2021). However, projects are permanently embedded in a context (e.g., the project portfolio) unsuitable for agile methods (Canonico and Soderlund, 2010; Kaufmann et al., 2020). Managers of project portfolios face new challenges managing agile projects, predominantly if the

portfolio consists of traditionally managed projects (e.g., waterfall approach) (Sweetman and Conboy, 2018). The requirements of agile projects are different from those of traditionally managed projects. Whereas traditional projects have a clear objective, agile projects often have a rough objective and evolve throughout the project (Serrador and Pinto, 2015; Marzi et al., 2021). As a result, controlling mechanisms by portfolio management might not fit the needs of agile projects. Tensions might arise between teams of agile projects and traditional project portfolios because the value contribution of agile projects may be difficult to see at the portfolio level (Sweetman and Conboy, 2018; Hennel and Rosenkranz, 2021). On the other hand, a controlled environment in the project portfolio can also create the necessary framework for agile teams to make decisions quickly (Petit, 2012; Hobbs and Petit, 2017; Kock and Gemünden, 2020). Thus, it remains unclear how agile projects behave in an elsewhere traditionally managed environment like the project portfolio. Further, quantitative evidence of agile practices under consideration of their context is scarce (Dyba and Dingsoyr, 2008; Bäcklander, 2019).

To conclude the literature gap on agile values in projects and project portfolios, I pose the first research question:

Research Question 1: *How can managers of projects and portfolios manage tensions that arise from implementing agile values to achieve project and portfolio success?*

In addition to agile values, sustainability could create paradoxical tensions between the sustainable and existing competitive strategies, which at first glance appears to be a disadvantage for decision-makers (Hahn et al., 2014; Hengst et al., 2020). A sustainable orientation describes the organizational efforts to establish awareness among employees and to make organizational operations more sustainable (Du et al., 2016). Sustainability orientation's impact on innovation performance, such as new product development, has proven positive, adding a competitive incentive for firms (Claudy et al., 2016; Du et al., 2016; Cheng, 2018; Jagani and Hong, 2022).

Innovation portfolios provide a relevant context to observe the effects of a sustainability orientation due to their role in implementing strategies. The portfolio level could reveal potential tensions between strategies and the impact of sustainability orientation on the ability to innovate. On the portfolio level, decision-makers select projects based on the given requirements, where, for example, sustainability could add complexity (Kester et al., 2011). Other strategic orientations have been shown to affect the innovation performance of the portfolio (Salomo et al., 2008; Talke et al., 2011; Kock and Gemünden, 2020; Kaufmann et al., 2021). Yet, no research investigated the influence of sustainability orientation on innovativeness in innovation portfolios compared to other strategic orientations (Brook and Pagnanelli, 2014). An ongoing debate is whether sustainability orientation supports incremental or radical products and processes. On the one hand, incremental product improvements may be possible, such as replacing parts of current products to make them more resource-efficient (Bos-Brouwers, 2009).

On the other hand, the new orientation allows portfolios to tap into radical new technologies or markets (Claudy et al., 2016; Du et al., 2016; Klein et al., 2021).

When making decisions, individuals may need to weigh the cost-effectiveness of product components against their sustainability, which can be very expensive. Further challenges of sustainability are balancing long-term future-oriented perspectives with short-term adaptability (Slawinski and Bansal, 2015). Paradoxical tensions are not necessarily detrimental but put companies in situations that require creativity. According to paradox theory, when properly managed, paradoxes can be beneficial and lead to innovation (Smith and Lewis, 2011). Former research found qualitative evidence of what type of tensions arise when introducing sustainability strategies and how to manage them, but stayed unsure about the outcome of those tensions (Smith and Lewis, 2011; Hahn et al., 2015; Hengst et al., 2020). Although case studies have predominantly served to identify contextual factors, exploring boundary conditions for paradoxical situations and responses remains an imperative task (Andriopoulos and Lewis, 2009; Carmine and De Marchi, 2022). Thus, there is still a call to investigate boundary conditions in sustainability research of paradoxical situations (Hahn et al., 2017). Therefore, it remains unclear under what conditions paradoxical tensions between sustainability and competitiveness strategies lead to preferred outcomes.

The goal of project portfolios is to align their projects strategically. Subsequently, portfolios focus on strategy execution (Meskendahl, 2010; Martinsuo and Killen, 2014; Clegg et al., 2018). Implementing a new sustainability strategy makes its effects especially evident at the project level, where project endeavors must actively integrate and enact sustainability requirements. Research on sustainability in portfolio management focused on the sustainability assessment of projects and the correct selection of projects according to the sustainability strategy (Aghajani et al., 2023). Projects conducted at a geographical local level are referred to as living labs (Voytenko et al., 2016; Coffay et al., 2022). Research demonstrated that living labs could lead to innovative solutions (Nevens et al., 2013; Compagnucci et al., 2021). However, the geographical effects of living labs are still insufficiently explored. Agglomeration research suggests that the concentration of activities in a specific geographic area could lead to higher financial or innovation performance (Carlino and Kerr, 2015). It is important to note that firms may benefit differently from these effects at the urban level (Mathias et al., 2020) and that these effects could also appear in a living lab setting (Nevens et al., 2013; McCrory et al., 2020). Establishing a living lab by different actors during the project proposal phase has not been researched yet despite the potential risks and uncertainties involved (Fuglsang and Hansen, 2022). Longitudinal research on the emergence of living labs is lacking, especially regarding possible agglomeration effects that may occur during the project planning phase (Hossain et al., 2019).

Concluding the above-mentioned potential challenges and opportunities of sustainability orientation for projects and project portfolios, I pose my second research question:

Research Question 2: *How can managers projects and portfolios manage tensions that arise from implementing sustainability values to achieve project and portfolio innovativeness and, eventually, success?*

1.3 Conceptual Background

1.3.1 Paradox Theory

Tensions are, by definition, often paradoxical and, therefore, persistent and not solvable (Smith and Lewis, 2011; Miron-Spektor et al., 2018; Lewis and Smith, 2022). Scholars describe paradoxical tensions as contradictory that "seem logical in isolation but absurd and irrational when appearing simultaneously" (Lewis, 2000, p. 760). Organizational-level paradoxes can arise due to the increasing number of stakeholders and their diverse requirements, resulting in conflicting goals and strategies (Smith and Lewis, 2011). The surge in research is because, if appropriately managed, these paradoxes provide companies with a competitive advantage (Miron-Spektor et al., 2011). In innovation management, the tensions between exploration and exploitation facilitate the development of novel ideas (March, 1991; Tushman and O'Reilly, 1996; Andriopoulos et al., 2017). Managing strategies range between focusing on an extreme pole at the cost of the other opposing pole and entities (individuals, sub-groups, organizations) working themselves through the tensions (Putnam et al., 2016). Research stated that cognitive frames can act as triggers to manage tensions and generate innovative ideas (Miron-Spektor et al., 2011; Smith and Lewis, 2011).

Tensions can impact decision-making, putting decision-makers under pressure to integrate multiple conflicting demands simultaneously. Employees and stakeholders should expect clear strategic guidance. Previous research has found that different decision-makers respond to paradoxical tensions with varying leadership practices. However, embracing the complex environment is often the best approach (Smith, 2014). This is similar to sustainability research, where managers "accept tensions and accommodate conflicting yet interrelated economic, environmental, and social concerns, rather than eliminate them" (Hahn et al., 2014, p. 466).

Paradox theory is frequently employed in sustainability research. Companies face a dilemma between achieving financial goals and fulfilling social responsibilities (Hahn et al., 2017). Additionally, tensions may arise when companies attempt to implement ecologically sustainable strategies while maintaining a competitive strategy (Hengst et al., 2020). Managing strategies hold for sustainable tensions as research suggests that balancing/working through these tensions results in better outcomes than focusing on pole only (Hahn et al., 2015; Bansal and Song, 2017; Hahn and Pinkse, 2022).

1.3.2 Project Portfolio Management

Project portfolio management oversees consolidating an organization's projects within a portfolio. The goal of project portfolio management is to support managers in selecting the appropriate projects that contribute to the company's strategy while considering its scarce resources (Martinsuo, 2013; Martinsuo and Killen, 2014; Kock and Gemünden, 2020). Project portfolio management is an ongoing process composed of two repeating phases: the portfolio structuring and the portfolio steering phase (Beringer et al., 2013). During the portfolio structuring phase, the portfolio board selects projects based on various indicators, some of which are quantitative and some qualitative. These indicators may sometimes conflict (Dixit and Pindyck, 1994). During the steering phase, portfolio management monitors the projects and adjusts resources if necessary (Müller et al., 2008; Kock et al., 2020). Here, projects can also be terminated. Project portfolios and their projects do not exist as independent units but operate within an environment that influences decision-making, shifting, for example, decision-makers' attention (Kaufmann et al., 2021). Therefore, contingencies impact these decisions (Donaldson, 2001). Contingency factors can be internal, such as the practiced culture, or external, such as environmental turbulence (Canonico and Soderlund, 2010). Projects operate in the portfolio context, which is why portfolio management processes influence projects.

Scholars assess portfolio success through various dimensions, whose composition can differ among studies (Jonas et al., 2013). The following five dimensions are predominant: future preparedness, average product/ project success, strategic implementation success, portfolio synergies, and portfolio balance (Cooper et al., 2001; Kester et al., 2014; Kock et al., 2015; Kaufmann et al., 2021). Future preparedness describes the extent to which companies invest in projects and products that guarantee their long-term survival (Shenhar et al., 2001; Kaufmann et al., 2021). Decision-makers achieve this by choosing innovative projects that can potentially gain a competitive advantage in the future (Kock et al., 2015). The average product/ project success measures how the individual products or projects achieve their planned market and profitability goals. Strategic implementation success reflects aligning the portfolio’s projects with the company’s strategy (McNally et al., 2013). It allows portfolio management to ensure that resources are allocated to projects contributing to strategic objectives (Dietrich and Lehtonen, 2005). Portfolio synergies originate from leveraging project synergies, minimizing redundant work (Meskendahl, 2010). A portfolio is balanced if it holds similar amounts of projects that strive for new and existing competencies or technologies (Cooper et al., 2001). Managers tend to invest more in existing knowledge areas, even though a good balance is vital to be successful (Uotila et al., 2009).

To measure single project success, scholars traditionally relied on the iron triangle (in time, budget, and scope), focusing on project management success measures. An external economic view on project success comprises achieved market and profitability goals, particularly financial ones (Gemünden et

al., 2005; Kock et al., 2011; Zwikael and Meredith, 2021; Kaufmann and Kock, 2022). Recent reviews revealed that the success measurement has evolved in recent years, including other dimensions, such as customer satisfaction, impact on customers/ project teams, and green success, emphasizing that project success depends on the type of projects and industry (Ika and Pinto, 2022).

Scholars have identified two factors that significantly contribute to portfolio success: innovativeness and agility. Portfolio innovativeness refers to the market and technological novelty of a portfolio's projects (Schultz et al., 2013). Thus, radical innovation is associated with greater innovativeness (Abetti, 2002). Portfolio innovativeness is related to higher performance measurements such as new product development success (Schultz et al., 2013), portfolio success (Kaufmann et al., 2021), or overall firm performance (Salomo et al., 2008; Talke et al., 2011). By selecting innovative projects that offer new market value, companies can provide customers with unique benefits from their products, helping them become first movers and gain a monopoly position (Zhou et al., 2005). Technological innovativeness leads to superior performance as it involves the accumulation of tacit knowledge, which increases protection and makes it more difficult for competitors to imitate. Additionally, there are marketing effects on customers who see the company as a pioneer, similar to market newness (Kock et al., 2011).

Portfolio agility refers to the capacity of project portfolio management to quickly adapt to changing circumstances, particularly by reallocating resources to more promising projects (Kester et al., 2011; Kester et al., 2014). Conceptualizations on agility are distinct. They perceive agility as a capability (Tallon et al., 2019). The capacity for continuous self-improvement can provide companies with a competitive advantage (Teece, 2007). Likewise, companies must be able to discontinue projects if they can no longer generate added value (Unger et al., 2012). Therefore, former research found that portfolio agility positively affects a portfolio's decision-making quality (Kock and Gemünden, 2016). Good decision-making quality among decision-makers benefits the process of starting new projects and discontinuing old ones (Queiroz et al., 2018).

1.4 Overview of Dissertation

To answer the research questions, I rely on five studies investigating different challenges on the portfolio and project levels and their effects on respective outcomes. Therefore, I structure the dissertation into two parts, each relating to one thematic field of tensions that could affect project and portfolio success. The first part consists of studies A and B, which examine the challenges and opportunities of agility on the project and portfolio levels. Study A examines the impact of agile practices on project-level teamwork quality and success while considering potential conflicts with traditional portfolio management. Meanwhile, study B explores the relationship between dynamic

capabilities and portfolio success through portfolio agility, recognizing that firms may face challenges balancing agility with efficient resource utilization. The second part of this dissertation discusses the effects of a sustainable focus and potential tensions that may arise at the project and portfolio levels. Three studies contribute to the focus topic. At the project level, study C examines the impact of agglomeration effects on urban actors in living labs and their ability to innovate. Given the lack of research on sustainability orientation in portfolio management, I am conducting two portfolio-level studies. Study D examines the impact of sustainability orientation on portfolio innovativeness and success. Study E complements study D by examining the effects of the emerging tensions between sustainability and competitive strategies on the innovativeness of portfolios and the contextual factors that influence this relationship. In Table 1, I summarize the five studies, including title, research question, type of tension, and research method. In the subsequent section, I elaborate on the five studies in more detail.

Table 1. Dissertation's studies overview.

Study	Title	Research question	Tensions	Method	Data Source
A	Agile Projects in Non-Agile Portfolios: How Project Portfolio Contingencies Constrain Agile Projects' Teamwork Quality	*What is the relevance of agile practices for TWQ and, eventually, project success? How do PPM contingencies of the portfolio structuring (business case existence, strategic clarity) and steering phase (operational and strategic control) interact with agile practices to predict teamwork quality?*	Agile projects vs traditional project portfolio management	Generalized least squares regression with 378 projects nested in 100 portfolios	1st multi-informant survey-based study
B	The Interplay between Dynamic Capabilities' Dimensions and Their Relationship to Project Portfolio Agility and Success	*How does the interplay of dynamic capabilities' dimensions of sensing, seizing, and reconfiguring relate to project portfolio agility and, eventually, success?*	Being agile while at the same time keeping the portfolio strategically aligned and utilizing the resources efficiently	Structural equation modeling and hierarchical regression with 135 portfolios	1st multi-informant survey-based study
C	The Relevance of Urban Agglomeration Micro-Foundations for the Emergence of Innovation in Living Labs: A Qualitative Field Study	*Which underlying agglomeration mechanisms lead to trade-offs between different living lab actors, and how do they develop over time?*	Local trade-offs	Two-year ethnographic field study	34 interviews and additional case data
D	The influence of sustainability orientation in innovation portfolios	*How does a sustainability orientation relate to an innovation portfolio's innovativeness and, eventually, success?*	Paradoxical sustainability tensions	Structural equation modeling of 115 innovation portfolios	2nd multi-informant survey-based study
E	Do sustainability tensions harm or benefit innovation portfolios? A paradoxical perspective	*How do contextual factors moderate the influence of sustainable strategic tensions on portfolio innovativeness?*	Paradoxical sustainability tensions	Hierarchical regression of 106 innovation portfolios	3rd multi-informant survey-based study

Research Study A investigates how agile practices support a project team's teamwork quality and project success under consideration of traditionally managed portfolios. Agile practices accelerate product development through autonomously working project teams (Highsmith, 2009; Hoda et al., 2012). They are characterized by their iterative planning and execution cycles, continuous customer or user feedback, and regular presentation of interim results, preparing project teams to react to dynamic environments better (Bianchi et al., 2020). Former research traces positive performance outcomes of agile teams back to, besides its accelerating effect, better team collaboration (Lindsjørn et al., 2016; Baham and Hirschheim, 2022). However, quantitative research on project collaboration outcomes of agile practices is scarce, often solely observing agile teams without comparing them to traditionally managed project teams (Lindsjørn et al., 2016). Considering the context, agile projects still operate in environments based on conventional management methods (i.e., traditionally managed portfolios) (Sweetman and Conboy, 2018). Here, problems could arise due to distinct requirements from those traditionally managed contingencies that differ from an agile environment (Stettina and Horz, 2015; Kaufmann et al., 2020). Thus, it remains unclear whether agile practices positively relate to teamwork quality and success (i) and if project portfolio management contingencies influence this relationship (ii).

We hypothesize that the positive relationship between agile practices and project success is mediated by teamwork quality. Further, project portfolio management comprises two phases: structuring and steering (Kock and Gemünden, 2020). In portfolio structuring, decision-makers prioritize and select the portfolio's projects. Here, a business case and strategic clarity support transparency during the process. The former refers to the systematic use of business cases for project selection, mandating projects to justify their business case (Kopmann et al., 2015). The latter refers to the widespread understanding of the strategy within the organization (Kock and Gemünden, 2016). Portfolio steering involves continuous monitoring and coordination of ongoing projects throughout their life cycle. Two fundamental components of portfolio steering are operational and strategic controls. Operational control demands routine assessment of each project's objectives (Cooper et al., 1999) and strategic control necessitates the ongoing evaluation of the established strategy (Kopmann et al., 2017). Through the lens of contingency theory, projects are situated in and influenced by their context, which is the project portfolio (Hanisch and Wald, 2012). Here, project portfolio management guides those projects, so we propose that portfolio contingencies representing portfolio structuring and steering positively moderate the relationship between agile practices and teamwork quality.

We test our hypotheses through generalized least square regression using a multi-informant sample of 378 projects nested in 100 project portfolios. We find that agile practices positively relate to teamwork quality and that teamwork quality partially mediates the relationship between agile practices and project success, confirming prior findings on positive outcomes of agile practices (Moe et al., 2010; Hoda et al., 2012; Serrador and Pinto, 2015; Hoda and Murugesan, 2016; Lindsjørn et al., 2016). Through agile

practices, project teams are encouraged to communicate more and put more effort into their work due to regular meetings and shared work ethic, supporting simple task alignment. Surprisingly, portfolio contingencies (i.e., business case existence, strategic clarity, and operational control) negatively moderate and, therefore, weaken the relationship between agile practices and teamwork quality. Hence, traditional approaches might limit agile project teams' autonomy and creativity (Kopmann et al., 2015; Hennel and Rosenkranz, 2021). If project portfolio management does not adapt control mechanisms to agile practices, agile project teams will have difficulties prioritizing between customer requirements and a company's strategy, for example. Overall, the study demonstrates that agile practices are suitable for agile teams to support teamwork quality and project success. Additionally, it emphasizes the importance of organizational commitment to agile practices and the need to scale these practices beyond the project level. Companies must recognize the differences in requirements between agile and traditional projects, adapt established routines when appropriate, and implement agile practices selectively.

Research Study B explores the importance of dynamic capabilities' dimensions for project portfolio agility and its success. In an increasingly fast-paced world where change is harder to foresee, project portfolios must adapt rapidly to survive in the competitive market (Kester et al., 2014; Kock and Gemünden, 2016). However, it is still unclear how portfolios can attain this agility and maintain resource efficiency without simply offsetting this adaptability with more resources (Hoffmann et al., 2020; Muruganandan et al., 2022). One concept to cope successfully with dynamic environments is dynamic capabilities (Schilke, 2014). "A dynamic capability is the capacity of an organization to purposefully create, extend, or modify its resource base" (Helfat et al., 2009, p. 1). A prominent conceptualization of dynamic capabilities is the three dimensions of sensing, seizing, and reconfiguring by Teece (2007). Sensing refers to identifying changes and opportunities in the environment, seizing involves exploiting these opportunities, and reconfiguring means adapting organizational resources when necessary. In former research, the conceptualization of dynamic capabilities is two-fold, either as an overall second-order construct (Tanriverdi and Venkatraman, 2005) or as three first-order dimensions (Schilke, 2014). Both conceptualizations are valid, emphasizing the importance of understanding how these perspectives can coexist. However, the two conceptualizations are constrained in their ability to explain outcome variations resulting from interconnections in sensing, seizing, and reconfiguring processes.

In the existing literature, applying a dynamic capability framework to project portfolio management (PPM) has identified PPM itself as a dynamic capability. However, using a second-order dynamic capability for PPM has been criticized for providing only surface-level insights. Current research on the multi-dimensional aspects of dynamic capabilities in PPM has been predominantly qualitative and conceptual, with limited quantitative studies that did not directly operationalize dynamic capabilities. There is a recognized need for further investigation into the mediating mechanisms between dynamic

capabilities and performance outcomes. Consequently, we propose a quantitative study addressing the multi-dimensional nature of dynamic capabilities to understand better how they contribute to portfolio agility and, ultimately, to the success of project portfolios, elucidating how firms achieve flexibility while maintaining efficiency.

We propose that the complementarity of dynamic capabilities' sensing, seizing, and reconfiguring positively relates to portfolio agility and, eventually, portfolio success. On the one hand, dynamic capabilities enable companies to challenge their established capabilities regularly. Companies are further able to seek and exploit upcoming opportunities under consideration of a company's scarce resources (Killen and Hunt, 2010). Thus, dynamic capabilities contribute to portfolio agility, so we hypothesize a mediation (Schilke et al., 2018). On the other hand, we argue that portfolio management should execute dynamic capabilities simultaneously, proposing a complementarity of the three dimensions by Teece (2007). Given that project portfolio management is a continuous process, persistent evaluation of prevailing decision-making mechanisms becomes imperative, especially in dynamic environments (Kaufmann et al., 2021). Thus, we further hypothesize a three-way interaction of sensing, seizing, and reconfiguring.

Through a multi-informant study of 135 project portfolios, we test our hypotheses. We use two different methods to test the hypotheses. With structural equation modeling, we found that dynamic capabilities are positively related to portfolio agility, which is, in turn, positively related to portfolio success. Further, portfolio agility mediates between dynamic capabilities and portfolio success. Hence, dynamic capabilities enable project portfolios to change their resource base quickly (Schilke et al., 2018). We show that dynamic capabilities well reflect the portfolio management process and constitute a relevant antecedent for portfolio agility (Killen and Hunt, 2010; Petit, 2012). However, we use hierarchical regression to test the interaction effect between the three dimensions and find they are not entirely complementary.

In conclusion, with our study, we could show the relevance of each dynamic capability dimension for project portfolio management and its contribution to exploiting internal and external potential. Further, we clarified the significance of portfolio agility in contributing to its overall success. Practitioners should periodically reassess their existing project portfolio management (PPM) capabilities to consider how new PPM practices, such as scaled agile portfolio management, can add value to the project portfolio and thereby foster the cultivation of dynamic capabilities.

Research Study C investigates the unequal distribution and variable benefits of agglomeration effects in urban living labs, emphasizing that such effects rely on specific partners, micro-foundations, and project timelines. Living labs are initiatives driven by municipalities or public authorities and serve as platforms for real-life experimentation of innovative ideas designed to be customer-focused, with citizens as the primary customers (Gascó, 2017; Kronsell and Mukhtar-Landgren, 2018; Compagnucci

et al., 2021). Living labs are used in urban areas to develop sustainable solutions as cities often witness unsustainable behavior (Voytenko et al., 2016; Kroh, 2021; Coffay et al., 2022). While research on living labs focuses on established projects, it may overlook the need to address pre-project barriers and risks (Fuglsang and Hansen, 2022). Although confined spaces are characteristic of living labs, little research has been conducted on the effects of geographical clustering on living labs (Nevens et al., 2013; McCrory et al., 2020). Agglomeration theory offers insights into why certain urban actors benefit more from the geographical location regarding financial and innovative gains than others (Capozza et al., 2018). Scholars have identified three micro-foundations that describe how agglomeration effects emerge: *sharing* resources, gains, and risks; *matching* resources; and *learning* through generation, diffusion, and accumulation (Duranton and Puga, 2004). Living labs often occur in geographical clusters, and the three dimensions serve as an explanatory approach to the different opportunities and barriers individual actors face. Consequently, we investigate which underlying agglomeration mechanisms lead to trade-offs between other living lab actors and if they change over time.

We answer our research question by conducting a qualitative case study with triangulated data from 2020 to 2022. Our case represented a living lab with multiple parties from universities, industry, and municipalities in one city. We collected interview data from 34 informants who engaged in project work. They either worked at universities or in the industry. Further, we could do field observations (e.g., participation in project meetings) and access documentary data (e.g., project proposals, project reports, etc.). We analyzed the interviews by assigning primary and secondary codes, which captured various project participants' actions and agglomeration micro-foundations.

We observed varying behaviors within the micro-foundations of both the university and industry sides and during the project proposal and familiarization phases. The micro-foundations of sharing within the living lab were evident. Yet, the benefits were not immediately apparent on both sides, with the university side realizing gains from specialization after the project proposal phase. Challenges on the industry side, such as limited capacities and personnel cost subsidies, hindered the exploitation of potential savings. However, the project facilitated innovative approaches to optimize employee working time.

Regarding matching on the university side, the living lab enhanced job matching quality and chances. The academic side retained employees for the long term, facilitated by financial support. On the industry side, the living lab attracted companies aligning with the energy transition goals. However, subcontracting limitations after the project's start hindered optimal resource matching. Task matching across project partners focused on refining tasks during the proposal phase, with technological solutions requiring cross-system collaboration. The familiarization phase showcased expanded matches and successful cross-sectoral dialogue, emphasizing the living lab's role in bringing diverse disciplines together.

There was a chronological progression in the learning dimension, with initial knowledge generation occurring among project partners in the project proposal phase, followed by diffusion in the second phase after project partners had established contractual obligations. Knowledge diffusion in the controlled industry became more feasible after the project's start, with specialized personnel contributing to regular subproject meetings. Cross-project knowledge exchange increased after the project started through regular meetings and cross-cutting sessions, fostering collaboration and examining facts within a larger system. The accumulation of knowledge allowed partners to draw on prior experiences, implementing successful practices in the current living lab.

Our study enriches the living labs literature by addressing pre-project phase challenges, emphasizing the support role of municipalities. Furthermore, we heighten awareness of varying industry and university perspectives, highlighting their distinct starting points in living lab initiatives. Lastly, we qualitatively explored micro-foundations of urban agglomeration effects to understand the network structure and interplay among actors comprehensively. Based on our results, we can give recommendations to policymakers, living lab organizers, and industry partners.

Research Study D delves into the interplay between sustainability orientation and decision-making processes within innovation portfolios because a sustainability orientation might operate as an additional boundary condition, wielding a profound impact on decisions in innovation portfolios. Strategic orientations exert a significant influence on the decisions regarding the initiation of new projects (Spanjol et al., 2012). Thus, they influence innovation outcomes and can support decisions toward more innovative projects and performance (Talke et al., 2011; Schweiger et al., 2019). Sustainability has emerged as an essential facet of a company's strategies because organizations saw a potential competitive advantage, and governmental regulations mandated the integration of specific sustainability aspects (Dixon-Fowler et al., 2012). Consequently, scholars were interested in sustainability orientation and its positive effects on innovations (Klein et al., 2021), new product development (Claudy et al., 2016; Du et al., 2016; Zhao et al., 2021), sustainable NPD (Jagani and Hong, 2022), and green innovation (Cheng, 2018) on the organizational level. Diverging from other strategic orientations, sustainability orientation aspires not only to financial gains but also to encompass non-financial objectives, thereby adding complexity to product development (Gatignon and Xuereb, 1997; Hengst et al., 2020). Further, an ongoing discussion on incorporating sustainability engenders incremental or radical innovation in an organization's products and processes (Bos-Brouwers, 2009; Hoogendoorn et al., 2020). This discourse underscores the potential insights from innovation portfolios, which implement a company's innovation strategy and, therefore, are highly dependent on strategic orientations (Salomo et al., 2008; Talke et al., 2011; Kaufmann et al., 2021). In innovation portfolio literature, research on sustainability is scarce, and the effects of sustainability orientation have not yet been investigated (Aghajani et al., 2023). Thus, we want to explore how a sustainability orientation relates to an innovation portfolio's innovativeness and, eventually, success.

We propose a positive mediation of portfolio innovativeness between sustainability orientation and portfolio success. The rationale hinges on the impact of sustainability orientation in generating market opportunities and demands, compelling decision-makers to enhance their market knowledge and invest in emerging technologies. Consequently, this facilitates innovation portfolios to delve into novel markets and technologies, enhancing portfolio innovativeness. Ultimately, we posit that sustainability is positively related to portfolio success through innovativeness, as it positions organizations as first movers, allowing them to capture market share, fostering a long-term perspective on the portfolio landscape, and cultivating balance by selecting riskier projects. Our method is based on a diverse industry sample of 115 innovation portfolios. We conceptualize sustainability orientation as a three-dimensional construct consisting of cultural, strategic, and structural aspects. Other studies used two dimensions for the conceptualization, drawing upon the significance of a company's commitment to sustainability and the tangible initiatives it has embraced (Claudy et al., 2016; Du et al., 2016; Cheng, 2018; Klein et al., 2021). In contrast to other studies, we split the company's commitment, encompassing both the overarching strategic outlook (top-down) and the cultural importance (bottom-up) associated with sustainability orientation (Adams et al., 2016). Through structural equation modeling, we find that sustainability orientation is positively associated with portfolio innovativeness and portfolio success but only partially mediated by portfolio innovativeness. Thus, we also found a direct relationship between sustainability orientation and portfolio success. Due to operational efficiencies, a sustainability orientation might also directly influence the average project success of a portfolio. Further, sustainability orientation might also directly affect the future preparedness of an innovation portfolio because of sustainability regulations (e.g., EU reporting requirements) forcing the portfolio to respond proactively (Lindberg et al., 2019). Lastly, partial mediation exists due to the contingency of sustainability orientation on additional factors within the innovation portfolio and its environment (e.g., strategic agility, pressure from stakeholders, or the industry).

With our study, we contribute to research on sustainability orientation in innovation management by demonstrating its advantages for new product development. We showed the relevance of another strategic orientation for innovation portfolios. Practitioners should be aware that introducing an additional strategy, in conjunction with the innovation strategy, may engender potential challenges, given the prospect of competing requirements. Hence, a comprehensive commitment to sustainable orientation is essential for navigating such intricacies.

Research Study E posits that tensions between financial and sustainability strategies can positively influence the innovativeness of an innovation portfolio when they occur in a specific organizational context (i.e., high entrepreneurial orientation and innovation climate). Companies may introduce sustainability strategies that stay in conflict with their competitive strategy (Hengst et al., 2020). Traditionally, sustainability scholars have viewed resulting tensions between strategies as a disadvantage for organizations (Hahn et al., 2014). However, paradox theory suggests that if managed

correctly, opposing tensions can also positively affect organizations (Miron-Spektor et al., 2011; Smith and Lewis, 2011). For instance, innovation researchers illustrated the beneficial impact of opposing activities, such as exploration and exploitation, on innovation outcomes (March, 1991; Tushman and O'Reilly, 1996). Research calls for a better understanding of contextual factors and boundary conditions in managing tensions in sustainability (Hahn et al., 2017). While there is existing quantitative research on contingency factors at the team level (Miron-Spektor et al., 2011), sustainability studies tend to rely predominantly on case studies for contextual factors, which presents a significant challenge (Andriopoulos and Lewis, 2009; Carmine and De Marchi, 2022).

An appropriate context for studying decision-making under different strategies is innovation portfolio management, as decision-makers may perceive tensions at this level. Previous research emphasizes the importance of dynamic decision-making when strategic paradoxes arise (Smith, 2014). Thus, while living under high uncertainty, innovation portfolios provide the perfect basis for dealing with tensions and providing the proper framework. As such, we want to examine what contextual factors might influence the relationship between tension and innovativeness.

We propose that two factors reflecting an organization's strategic and cultural dimensions influence the relationship between tensions and innovativeness (i.e., entrepreneurial orientation and innovation climate). An entrepreneurial orientation prioritizes innovative options and incorporates sustainability (Jansson et al., 2017). Firms with a high entrepreneurial orientation take risks, which facilitates the introduction of new products and technologies. They actively search for innovative solutions to sustainability issues and identify opportunities and necessary changes early (Klein et al., 2021). This proactive orientation helps manage sustainability tensions within the innovation portfolio by making them noticeable and allowing for adaptable responses.

Further, a strong innovation culture supports constructive and open debates, potentially dissolving hierarchical levels between the various stakeholders, which is essential when tensions arise (Hahn et al., 2015; Knight and Paroutis, 2016). Despite potential constraints arising from sustainability tensions (Hengst et al., 2020), an innovation climate encourages teams to overcome barriers creatively, leading to innovative outcomes through supportive and risk-taking behavior (Weiss et al., 2011). We rely on a cross-industry sample of 106 innovation portfolios to test our hypotheses. Through OLS regressions, we demonstrate no significant direct relationship between sustainability orientation and innovativeness. However, the introduction of the two moderators shows two positive moderations with entrepreneurial orientation and innovation climate, meaning that tensions have a positive relationship with innovativeness at higher levels of entrepreneurial orientation and innovation climate. Our contributions to literature are three-fold. We highlight the importance of effectively managing sustainability tensions for the organization's benefit.

Furthermore, we add to the paradox theory literature by identifying two contextual factors that can manage paradoxical tensions. These contextual factors further confirm earlier findings from the innovation portfolio management literature. Lastly, we call on top managers to support an innovation climate by establishing communities for knowledge exchange and not forgetting that tensions could harm a portfolio's innovativeness if not managed correctly.

Chapter 2 Research Study A:
Agile Projects in Non-Agile Portfolios: How Project Portfolio Contingencies Constrain Agile Projects' Teamwork Quality

Abstract:

Agile practices present one approach for firms to adapt to an increasingly dynamic and competitive environment. Although prior studies have investigated performance outcomes of agile projects, agile practices' consequences on a project team's collaborative processes have not yet been thoroughly analyzed. It also remains unclear whether practices on a higher organizational level, such as project portfolio management, support or constrain agile practices' benefits, especially if a firm simultaneously conducts traditionally managed and agile projects. Therefore, this study investigates the role of agile practices for a project's teamwork quality (TWQ) and project success and examines the influence of organizational contingencies. Specifically, we conceptually and empirically analyze the moderating impact of project portfolio management (PPM) practices on the relationship between agile practices, teamwork quality, and project success. A multi-informant analysis of 378 projects nested in 100 portfolios shows that agile practices positively relate to project success through TWQ. We find that traditional PPM practices such as business case existence, strategic clarity, and operational control constrain this relationship. Our study contributes to the literature on project teams and portfolio management by providing empirical insights on the interaction between project and portfolio management practices.

Classification in terms of this dissertation:

- **Tensions:** Agile projects vs traditional project portfolio management
- **Sample:** Multi-informant project portfolio management survey (n=378 projects nested in N=100 portfolios)
- **Method:** Generalized least squares regression

Publication:

Bechtel, Jadena; Kaufmann, Carsten; Kock, Alexander (2022): Agile Projects in Nonagile Portfolios: How Project Portfolio Contingencies Constrain Agile Projects' Teamwork Quality. In: *IEEE Transactions on Engineering Management*. DOI: 10.1109/Tem.2021.3130068.

An earlier version was presented at the European Academy of Management Conference 2021, online.

2.1 Introduction

Agile practices recently received significant attention in the literature on project management (Dyba and Dingsoyr, 2008; Stettina and Horz, 2015; Sweetman and Conboy, 2018), especially because they allow firms to flexibly react to environmental changes and reduce overall time-to-market (Beck et al., 2001; Highsmith, 2009). Agile practices are usually conducted by small, autonomous project teams (Hoda and Murugesan, 2016) that work in iterative planning and execution cycles and regularly present minimum viable products (Dyba and Dingsoyr, 2008). In general, agile practices stand out due to their strong focus on customer value. Agile teams intensively communicate not only within their team but especially with external stakeholders to identify customer needs and obtain regular feedback on prototypes (Williams, 2012).

Previous studies suggest that agile practices positively relate to performance outcomes (Lee and Xia, 2010; Serrador and Pinto, 2015; Bianchi et al., 2020). Compared to traditional project management practices, agile practices (e.g., Scrum) count on a team's internal collaboration rather than the plan-driven execution of tasks given by the project manager (Moe et al., 2008; Hoda and Murugesan, 2016). In particular, agile practices promote teams' internal collaboration processes, which could be a decisive driver of agile projects' success (Baham and Hirschheim, 2022). Yet, empirical evidence on agile practices' consequences for a project team's collaboration processes is still limited (Dyba and Dingsoyr, 2008; Bäcklander, 2019). Previous research used qualitative approaches (e.g., case studies or grounded theory methodology) and considered only one or a few agile software teams (Moe et al., 2010; Hoda et al., 2012; Hoda and Murugesan, 2016). One exception is Lindsjørn et al. (2016), who investigated teamwork quality (TWQ) in agile software teams and showed that TWQ positively relates to team performance, confirming findings in other teamwork studies (Pinto et al., 1993; Hoegl and Gemuenden, 2001; Hoegl et al., 2004). However, their sample did not allow them to compare agile and non-agile teams. Therefore, it remains unclear whether, first, agile practices increase project performance through elevated TWQ and, second, if agile practices are also beneficial for other project types besides software development. Thus, we formulate our first research question: *What is the relevance of agile practices for teamwork quality and, eventually, project success?*

A neglected perspective is that agile projects are not per se successful (Bianchi et al., 2020; Wiesche, 2021). As projects can be seen as temporary organizations, they depend on their external context (Stettina and Horz, 2015; Sweetman and Conboy, 2018; Kaufmann et al., 2020). Besides external contingency factors like uncertainty or the dynamic environment, also organizational factors can influence the performance of a project (Canonico and Soderlund, 2010). Therefore, the interplay between agile projects and project portfolio management (PPM), as the context in which a project operates, is recently discussed by research, which confirms that implementing agile practices poses new challenges to PPM (Stettina and Horz, 2015; Sweetman and Conboy, 2018; Kaufmann et al., 2020).

Prior empirical literature, which refers to portfolios consisting of traditionally managed projects, agrees on PPM success factors, for example, monitoring activities (Teller et al., 2014; Kopmann et al., 2015; Kock and Gemünden, 2020). When organizations introduce agile projects, project portfolios typically still contain traditionally managed projects. However, agile projects strongly differ from traditionally managed projects in terms of planning, goal-setting, execution, and collaboration. It remains unclear how established portfolio-level factors influence individual agile projects and their activities. To the best of our knowledge, no study analyzed PPM practices' influence on agile projects' processes or success. This is a highly relevant gap in the literature because agile projects' popularity is strongly growing. Established PPM success factors could potentially support agile project teams as those factors give agile teams orientation and help them to state their added value to the project portfolio (Petit, 2012; Martinsuo, 2013; Hobbs and Petit, 2017; Kock and Gemünden, 2020). We follow contingency theory to better understand how portfolio factors affect projects. This is highly suitable since we investigate organizational practices that might not be optimal for every context. We choose established success factors along the PPM process to determine the projects' organizational context. For the portfolio structuring phase, in which decision makers prioritize and select projects, we focus on business case existence and strategic clarity (Meskendahl, 2010). We focus on operational and strategic control for the portfolio steering phase, in which projects are monitored (Nguyen et al., 2018; Kaufmann et al., 2020). Therefore, our second research question is: *How do PPM contingencies of the portfolio structuring (business case existence, strategic clarity) and steering phase (operational and strategic control) interact with agile practices to predict teamwork quality?*

We test our hypotheses using a cross-industry, multi-informant, multi-level survey sample of 378 project teams nested in 100 project portfolios of medium- to large-sized firms. This study adds new insights to agile project management literature by providing quantitative empirical findings on how agile practices increase teamwork quality and thereby contribute to project performance (Hoda et al., 2012; Serrador and Pinto, 2015; Lindsjørn et al., 2016). Previous research investigated team processes only qualitatively (Moe et al., 2010) or did not consider the impact of agile practices on TWQ (Lindsjørn et al., 2016). This study's results suggest that the relationship between agile practices and the economic performance of a project is mediated through teamwork quality and that this finding applies to not only software but all project types. Second, we contribute to PPM literature by expanding contingency theory (Martinsuo, 2013) and answering the call for research on agile practices' interplay with their organizational context, namely the project portfolio (Moe et al., 2010; Sweetman and Conboy, 2018). We find a negative moderating influence of business case existence, operational control, and strategic clarity on the relationship between agile practices and teamwork. When introducing agile projects into conventional project portfolios, portfolio managers must be aware that factors relevant for portfolio success in traditional portfolios might lead to conflicts in agile project teams since they restrict their required flexibility. For practitioners, the study encourages the use of agile practices; however, the

results simultaneously highlight the constraining influence of established organizational characteristics and the need to adapt portfolio processes when introducing agile projects (Stettina and Horz, 2015; Sweetman and Conboy, 2018).

2.2 Conceptual Background

2.2.1 Teamwork in Projects

"A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems (for example, business unit or the corporation), and who manage their relationships across organizational boundaries" (Cohen and Bailey, 1997, p. 241). Project teams are temporary entities embedded in project portfolios, which only remain together until they fulfilled their purpose (Pinto et al., 1993). They operate beyond a department's routine work and tackle new tasks contributing to an organization's strategy (Jonas et al., 2013).

Achieving project success requires members of a project team to get along with each other well. To define a common understanding of good team collaboration, Hoegl and Gemuenden (2001) conceptualize teamwork quality along six dimensions: communication, coordination, balance of member contributions, mutual support, effort, and cohesion. Overall, the TWQ construct is an established predictor of team performance (Easley et al., 2003; Hoegl and Proserpio, 2004; Hoegl et al., 2004). Communication describes the exchange of information among team members and is characterized by openness and frequency. It is one of the most important factors for team and project performance (Katz, 1982). Coordination means that team members agree on individuals' work packages and subtasks and delegate them accordingly. Coordination routines include, for example, plans or simply scheduled meetings. Balance of member contributions refers to the respectful treatment of team members' knowledge. If team members can present their full potential to the team, contributions are balanced, considering team members' strengths and weaknesses. Hoegl and Gemuenden (2001) define mutual support as another important aspect of TWQ in interdependent tasks. Effort is the intensity or persistence individuals are willing to put into their tasks or activities. When their effort is high, team members are committed and have agreed to put their best into the common tasks. Last, team cohesion is a prerequisite for good TWQ (Beal et al., 2003). Team members with strong cohesion are proud to be part of the team. Thus, a team spirit might arise, leading to a stronger bond and greater productivity (Beal et al., 2003).

Prior research demonstrates that collaboration or dimensions of teamwork quality mediate several antecedents of project performance. Many antecedents of TWQ are behavioral and include, for example, a team's prosocial behavior (Hu and Liden, 2015), motivational attitude towards the team (Mathieu et

al., 2008), trust (De Jong and Elfring, 2010), or different leadership styles (Eva et al., 2019). For processual antecedents, Chen (2007) demonstrated that a working IT infrastructure and a decentralized organization structure lead to a higher interaction among team members and, lastly, to better NPD performance. Another study by Pinto et al. (1993) identified several factors that positively relate to team cooperation, the strongest being shared superordinate goals, team members' colocation, and common agreement on project team rules and procedures.

2.2.2 Agile Project Management and Agile Project Teams

Turbulent environments and competitive pressure require fast innovation processes for new products and services and the ability to adapt more quickly to new challenges. Nagel et al. (1995) describe agility as a firm's ability to recognize opportunities for competitive action and mobilize the necessary resources to take advantage of them. Agile project management methods were established to achieve this (Chakravarty et al., 2013; Serrador and Pinto, 2015). Whereas traditional project management strives to follow an initial plan and meet time, budget, and quality goals (Turner and Müller, 2003), agile methods—which originally evolved from software development—do not predefine a final outcome and time. Instead, one main characteristic of agile project management methods is "the ability to adapt to changes and divide the work into distinct iterations throughout the project" (Gemino et al., 2020, p. 2). A recent study by Bianchi et al. (2020) defined agile methods as the combination of the elements feedback, sprints, and specifications. We follow their definition; however, since they focused solely on software development projects and investigated agile projects in general, we define three universal underlying components of agile practices (Gemino et al., 2020). First, agile methods are characterized by *iterative planning and execution cycles*. Second, the iterations lead to a *regular presentation of interim results* of the projects (e.g., in the form of prototypes or minimum viable products). And third, agile methods *continuously gather customer or user feedback* to improve their product within the next planning cycle (Dyba and Dingsoyr, 2008; Bianchi et al., 2020).

Agile project management has two main advantages over traditional project management. First, product development is accelerated with the help of an iterative method characterized by iterative planning cycles (Conboy, 2009; Drury-Grogan, 2021). Second, after each cycle, the team creates a usable product and obtains direct feedback from the customer, which increases alignment with the customer and ensures higher chances of project success. Agile teams are often seen as collaborative working groups by nature (Drury-Grogan, 2021). The iterative working cycles force people to work closely together. What is more, the team is encouraged to self-organize and work autonomously [9]. Team members collectively decide which tasks to work on in the next iterative cycle and what steps are necessary to present the next interim result (Moe et al., 2008).

In general, project teams that collaborate well also perform well and contribute to a project's internal and external success and, consequently, to the organization (Edmondson and Nembhard, 2009). A

project's success can be determined in several ways, which also depend on the perspective of the different stakeholders (Gemünden et al., 2005; Sweetman and Conboy, 2018). For example, success can be measured from a project manager's perspective or the perspective of the owner or investor (Zwikael and Meredith, 2021). The former is often labelled project management success and concerns time, budget, and quality adherence (i.e., achieving the project plan) (Gemünden et al., 2005). From an investor's perspective, project success concerns the business success that can be measured by monetary indicators like market goals, profitability, and payback period (Gemünden et al., 2005; Zwikael and Meredith, 2021). As mentioned above, agile projects do not follow an initial plan but rather iteratively evaluate the specifications of the project outcome. Although project managers can eventually review an agile project's time and budget dimension (Bianchi et al., 2020), it can be problematic to compare traditional and agile projects according to plan adherence. Agile projects are also often customer and not organization oriented (Sweetman and Conboy, 2018). As the present study wants to compare agile and traditionally managed projects and adopt an overarching management perspective, an investor's perspective to project success is more appropriate. Therefore, in the following, we refer to the business success when using the term project success.

2.2.3 Project Portfolio Management as Organizational Context for Projects

Contingency theory states that relationships between an organization's characteristics and its performance depend on the environment in which the organization operates (Donaldson, 2001). Accordingly, no single form of organizing can be ideal for every environmental setting; we require a fit between environment and organization (Burns and Stalker, 1961). This underlying argument also applies to projects because a project is a temporary organization usually embedded in a larger organization, for example, the project portfolio of a company (Hanisch and Wald, 2012). The project portfolio (the collection of a company's projects) is governed by project portfolio management and thus constitutes the projects' context and environment. PPM overarchingly coordinates these projects and is a dynamic decision-making process supporting companies to identify, select, and execute the right projects in line with their strategy (Martinsuo, 2013). A project portfolio is effective if it reflects the firm's strategy, its projects are well balanced, and its overall value is maximized (Martinsuo and Lehtonen, 2007). Multiple stakeholders need to jointly execute the PPM process well to achieve those goals (Jonas et al., 2013). This process' characteristics essentially constitute the organizational environment for the projects. A project's organizational form, for example, shaped by agile practices, should fit this environment. In the following, we identify factors that characterize the portfolio management process and thus constitute suitable contingency factors for the team processes and performance of projects operating in the portfolio. Prior literature considers two main phases of PPM: *portfolio structuring* and *portfolio steering* (Kock and Gemünden, 2020).

In *portfolio structuring*, portfolio management aims at a portfolio composition that maximizes the organization's value. In practice, portfolio structuring usually follows a heuristic process relying on estimations (e.g., based on the project's net present value) that are sometimes contradicting and challenging to prioritize (Dixit and Pindyck, 1994). In this phase, stakeholders bring their views into the selection process, elevating the need for PPM to be transparent (Beringer et al., 2013). *Business case existence* and *strategic clarity* are two fundamental and highly established practices of portfolio structuring that both support transparency (Meskendahl, 2010; Kopmann et al., 2015; Kopmann et al., 2017). The *existence of business cases* refers to the systematic use and evaluation of business cases in project selection and the obligation for projects to argue their business case even if the project is considered mandatory (Kopmann et al., 2015). *Strategic clarity* means that the strategy is communicated and understood within the organization (Meskendahl, 2010; Kock and Gemünden, 2016), which is necessary to achieve a balanced and strategy-oriented portfolio. For example, a transparent strategy can support important portfolio decisions, which projects to select or terminate (Gutiérrez and Magnusson, 2014; Kock and Gemünden, 2016).

As part of *portfolio steering,* portfolio managers continuously monitor and coordinate ongoing projects throughout their life cycle (Müller et al., 2008; Kock et al., 2020). Managers need to monitor individual projects and the accumulated portfolio status in terms of strategic alignment (Nguyen et al., 2018) or cross-project risks (Teller et al., 2014). To achieve sufficient information quality across the portfolio, project managers need to regularly deliver reliable project information (Martinsuo and Lehtonen, 2007; Kock et al., 2020). At periodic meetings, project managers present the current project status and can request decision approval for the portfolio steering committee's other planned actions. In this regard, *operational control* describes portfolio managers' frequent examination of single projects' targets to check for changes and possible adjustments within the portfolio. Projects' strategic alignment is monitored before their start and during their execution (Cooper et al., 1999). Operational control is important since firms otherwise often discover difficulties or delays too late due to changing conditions and cannot take emendatory actions (Gardiner and Stewart, 2000). This becomes more important in turbulent environments, where more frequent portfolio control is necessary (Kock and Gemünden, 2016). Apart from monitoring projects, managers also need to regularly review if the strategy is still valid or if changed premises demand a reconsideration. *Strategic control* challenges the implemented strategy based on the gained information from projects. Early research called for continuous strategic control, meaning that the strategy is critically scrutinized at the strategy formulation and after the strategy implementation, instead of just controlling for potential deviations from the planned strategy (Kopmann et al., 2017).

Only a few studies empirically considered the interaction of project and portfolio levels, and they mainly concentrated on how project-level actions affect portfolio-level decisions and outcomes. Martinsuo and Lehtonen (2007) demonstrated that an effective PPM also requires highly effective project

management. Teller et al. (2012) showed that standardized management routines and processes on the project level and formalization of PPM have complementary effects on PPM quality, meaning one is ineffective without the other (Teller et al., 2012). Nguyen et al. (2018), vice versa, show that certain portfolio-level mechanisms influence decision-making processes on the project level. They revealed that operational control and the application of business cases are negatively connected with effectuation on the project level. These studies show the deep connection between projects and PPM, in that project teams are not only agents of the project portfolio but make decisive contributions to the portfolio management process. This stresses the relevance of an investigation of single agile project management processes in the context of higher-level PPM contingency factors.

2.3 Hypotheses

2.3.1 Agile Practices and Teamwork Quality

We argue that the underlying values and routines of agile practices positively affect teamwork quality through three mechanisms. First, routines of agile practices lead to higher intrateam communication. In common agile practices, team members attend regular meetings. For example, Scrum's daily stand-up meetings, retrospectives, and backlog meetings enable fast and iterative planning, leading to frequent information exchange between team members (Moe et al., 2010; Bäcklander, 2019). These routines force team members to work together intensively (Beck et al., 2001; Schwaber and Beedle, 2002; Highsmith, 2009).

Second, agile practices improve team coordination, a central dimension of TWQ. They follow structured processes that encourage presenting intermediate results (i.e., minimum viable products) and thus facilitate effective task coordination (Stettina and Horz, 2015). Additionally, roles in agile project management are clearly defined. The team moderator, for example, is in charge of the team members' external problems and of maintaining an effective working climate (Dyba and Dingsoyr, 2008). In traditionally managed teams, roles with responsibility focus more on delegating tasks, whereas comparative roles in agile project teams follow a more help-oriented approach (Hoda et al., 2012).

Third, members' effort most likely will grow in teams using agile practices. De Jong and Elfring (2010) explored a strong relationship between trust and team effort, arguing that "trust promotes effort because it affects a combination of the rational, normative, and affective considerations that codetermine team members' motivation to work hard on team tasks" (De Jong and Elfring, 2010, p. 539). Trust between team members is often found in agile project teams due to the underlying values of agile practices and especially the frequent team meetings (Dyba and Dingsoyr, 2008; Moe et al., 2010; Hoda et al., 2012). Thus, we conclude that agile project teams also put a high effort into their work.

Conclusively, the intensity of agile practices should be beneficial for the quality of teamwork since their underlying values and routines presents a suitable environment for collaborating teams. We formulate our hypothesis as follows:

H1: Agile practice intensity is positively related to TWQ.

2.3.2 TWQ as a mediator of agile practices on project success

Prior research consistently shows that TWQ positively relates to performance outcomes (Pinto et al., 1993; Hoegl and Gemuenden, 2001; Hoegl et al., 2004; LePine et al., 2008; Lindsjørn et al., 2016). As teamwork describes the interaction among team members, a highly collaborative team works effectively and is well coordinated (Mathieu et al., 2008). Consequently, it is more likely that the project accomplishes its objectives and is successful. However, agile project management changed the projects' requirements so that measuring project success with conventional indicators (e.g., time, budget, quality) does not adequately consider the benefits of agile practices(Drury-Grogan, 2021). Therefore, we define a project as economically successful if its product meets its market and profitability goals (market share, ROI, payback period).

Adding to the hypothesis above of agile practices' positive effect on TWQ and the already proven benefits of TWQ for project success, we hypothesize that TWQ mediates the positive effect of agile practices to project success. Agile project management is important for projects because it strengthens teamwork through its practices and consequently enhances project success. This mediating role is important for two reasons. First, by iteratively acquiring the product through agile practices, the project team remains flexible. Hence, coordination among tasks and team members becomes easier as the planning horizon can be divided into short incremental cycles, and a change in the project scope does not automatically lead to more coordination effort. The flexibility can then indirectly affect a project outcome through better team coordination. Second, presenting minimum viable products leads to more satisfied customers and team members, who will then put more effort into their work and behave more cohesively (Dyba and Dingsoyr, 2008). Early validation of the team's work by users and decision-makers, combined with the intensive feedback culture, leaves team members little room for doubt. This ultimately produces better products as fewer mistakes are made. So, user focus and the presentation of interim results likely lead to higher TWQ and, eventually, better project outcomes. Thus:

H2: Teamwork Quality mediates the relationship between agile practices and project success.

2.3.3 The Moderating Effects of Portfolio Management

Following organizational contingency theory, the effectiveness of organizational practices, such as agile practices, depends on the context. Since portfolio management practices determine the context in which projects operate, the portfolio processes' characteristics constitute contingency factors for single

projects. A "contingency is any variable that moderates the effect of an organizational characteristic on organizational performance" (Donaldson, 2001, p. 7). Therefore, we investigate the moderating effect of established practices in a portfolio's structuring phase—specifically, business case existence and strategic clarity—and steering phase—specifically, operational control and strategic control.

Business Case Existence. The business case is an established instrument for project prioritization and funding in the portfolio structuring phase (Einhorn et al., 2019). It is a document containing information about "estimates of the benefits, timescales, resource requirements (including costs), and risks of a project" (Kopmann et al., 2015, p. 530). Kopmann et al. (2015) empirically show that business case control is an essential portfolio management control mechanism that positively relates to project portfolio success. Effective business case control consists of three dimensions. First, *business case existence* describes the use and intensive analysis of project proposals' business cases in the portfolio structuring phase. Second, *business case monitoring* in the portfolio steering phase means continuously monitoring projects' business cases for changes in the project due to, for example, environmental dynamics to respond to them in a timely manner. Third, *business case tracking* determines the added value of the project for the company. Business case control is especially useful to track a project's realized outcome and customer value instead of only reviewing operational goals such as cost, quality, and time.

As the necessary dimension of business case control, we hypothesize that business case existence constitutes a central element for value and benefits realization empowering agile teams to demonstrate agile practices' benefits. A business case fulfills its central purpose in proving a project's value and recognizing changes early, which is particularly helpful for agile projects. A business case orientation in portfolios should leverage TWQ in agile teams for two reasons.

First, a business case increases the overall transparency in project portfolios: business cases create transparency in resource allocation because each project must justify its resource needs before initiation. Transparent resource allocation promotes cooperation on the company level and within the team because team members agree on transparent values (Jonas et al., 2013). Transparency in teams is an antecedent for team integrity, which ultimately leads to trust among team members (Palanski et al., 2010). Consequently, if agile practices are positively related to TWQ, the existence of business cases will strengthen this relationship as transparency is a common value in agile teams and positively affects collaboration (Hoda et al., 2012; Stettina and Horz, 2015). If portfolio management did not use business case control at all, it would have trouble validating and tracking the fast changes in agile teams. Hence, it would be harder for project teams to prove their value, and disagreements in the team might occur.

Second, business cases are a widely used instrument in PPM and an integral part of PPM standards (Kopmann et al., 2015). Thus, business cases are often mandatory for projects. Commitments everyone has to make stand for equality in the company. If project managers feel they are equally treated when

creating the business case, cooperation quality at the company level is better because the business case forms a basis for discussion. This initial structure should be helpful for agile projects to clarify their value and justify their existence to management and competing projects (Sweetman and Conboy, 2018). Business cases also provide senior management and project portfolio coordinators with a degree of certainty in project selection decisions and can avoid potential conflicts arising in the project's course (Nguyen et al., 2018). Without business cases, project portfolio and senior management might not even know that the project uses agile practices, setting incorrect expectations (Sweetman and Conboy, 2018). When teams feel misunderstood by portfolio management, team members can become insecure and dissatisfied, which mitigates agile practices' advantages for better coordination.

Therefore, we propose that the positive relationship between agile practice intensity and TWQ increases when there the portfolio applies business case control.

H3a: BC existence on portfolio level positively moderates the relationship between agile practice intensity and TWQ.

Strategic Clarity. PPM aims to select the right projects that fit the company's strategy (Cooper et al., 1999). Ultimately, a portfolio's project should reflect the company's strategic goals. Strategic clarity supports this implementation and is therefore essential for project portfolio success (Meskendahl, 2010; Kock et al., 2015).

We argue that strategic clarity on the portfolio level further strengthens the relationship between agile practice intensity and TWQ. As an agile project's final outcome is often unclear at the beginning, a clearly communicated corporate strategy provides an orientation to the project teams (Lee and Xia, 2010; Sweetman and Conboy, 2018). The main purpose of project portfolio management is identical for traditional and agile projects: linking projects to strategy and regularly reviewing them (Stettina and Horz, 2015). Serrador and Pinto (2015) showed evidence that the quality of a company's vision and goals positively moderates the relationship between agile practices and project success. They argued that projects that are more aligned with the company's strategy are supported better through PPM. Employees feeling supported by the organization are further encouraged. In their meta-analysis, Kurtessis et al. (2015) demonstrated that organizational support is positively related to trust, commitment, organizational identification, and self-efficacy. Thus, we argue that agile teams working in a company with a clearly formulated and transparent strategy will put more effort into their work and have a higher team cohesion. They are aware of the company's overall strategic path and can derive general expectations for their project team. Therefore, we propose:

H3b: Strategic clarity on the portfolio level positively moderates the influence of agile practice intensity on TWQ.

Operational Control. Continuous monitoring of the project portfolio means to analytically examine deviations between the planned and actual performance of the projects and the portfolio (Nguyen et al., 2018). With operational control, we refer to the project portfolio monitoring intensity. Kock and Gemünden (2016) found that operational control is positively related to decision-making quality in project portfolios, especially for a turbulent firm environment. Therefore, portfolio-level control is helpful to detect mismanagement or risky developments early in projects.

We hypothesize that a project portfolio's operational control positively moderates the relationship between agile practices and TWQ for two reasons. First, Sweetman and Conboy (2018, p. 12) point out that "[p]ortfolio managers must find the appropriate balance between control and autonomy in agile projects." They argue that the project team feels safer when they know that not all the responsibility rests on them. With higher operational control, team members should feel less weight on their shoulders, which allows them to better focus on their work and collaborate better. However, this advantage might decrease if the portfolio and its projects gain experience in agile project management, and project members learn how to act autonomously (Bäcklander, 2019).

Second, through operational control, portfolio managers detect risks and interdependencies between projects that might not be visible on the single project level. This can lead to optimized resource allocation and the use of synergies among projects (Teller and Kock, 2013) when portfolio managers make project teams aware of synergies and facilitate sharing of experiences to minimize risks. Agile project teams can particularly benefit from this because their environment is more volatile and not predictable. Early warnings of mismanagement from portfolio management enhance collaboration on the team level as team members can concentrate on their work rather than firefighting arising risks. We propose:

H4a: Operational control on the portfolio level positively moderates the relationship between agile practice intensity and TWQ.

Strategic Control. Strategic control consists of premise control (i.e., validating strategic assumptions) and implementation control (i.e., scrutinizing the pursued strategy) and focuses on internal and external environmental changes that might affect the strategy (Kopmann et al., 2017). It ensures that the intended strategy is not only implemented properly but also challenged on a regular basis. Strategic control enables managers to recognize emergent strategies in particular from projects due to changed external or internal conditions at the portfolio level. Therefore, a strategic control that takes place regularly not only implements the strategy top-down but is also willing to change the strategy due to new, bottom-up impulses.

We assume that strategic control strengthens the relationship between agile practice intensity and TWQ. Sweetman and Conboy (2018, p. 2) recognized that difficulties arise with agile projects if a project portfolio is enacted "in a top-down, centralized, and plan-driven way." They argue that such portfolios

lack adaptive behavior and are overwhelmed in dealing with agile projects. This would restrict the advantages of agile practices on TWQ because agile teams are less flexible in their project or product outcome. This problem could be counteracted by strategic control. Kaufmann et al. (2020) link emergent strategy recognition with agile capabilities and show that agile capabilities on a portfolio level enhance the recognition of emergent strategy because they enable intensive knowledge exchange and relationship quality among employees. A company with an adaptive strategy enabled through strategic control understands that agile projects do not have a set goal at the beginning. Also, firms with strong strategic control are more aware of emergent strategies and are supportive of agile teams as they know that emergent strategies are also needed for their success. Thus, we argue:

H4b: Strategic control on portfolio level positively moderates the relationship between agile practice intensity and TWQ.

Figure 1 summarizes the conceptual model of the study.

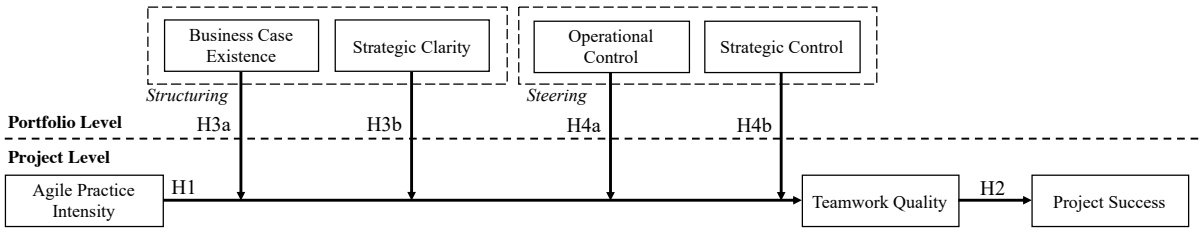

Figure 1. Conceptual model (Research Study A)

2.4 Method

2.4.1 Sample

The data was collected as part of a large cross-industry study that observed best practices and success factors in project portfolio management. First, we contacted the portfolio coordinators (e.g., portfolio managers, heads of PMO) from medium and large organizations and provided information about the study design, terms, and definitions. These managers were in charge of managing the project portfolio and were typically part of the project management office. Each portfolio coordinator answered a survey with questions relating to their business unit and its project portfolio. They were further instructed to approach a senior manager and three or more project managers in their portfolio to also participate in the study. The senior manager provided information on the portfolio's business environment. The project managers (median of four per portfolio) answered a survey referring to their most recently completed project to reduce a positive selection bias. The three-informant approach enabled us to evaluate both portfolio-level as well as single project constructs. The final sample comprised 378 projects of various types (R&D projects, investment and construction projects, IT and (re-)organization

projects) nested in 100 portfolios/firms (on average 3.8 projects per portfolio, median of four). Table 2 provides an overview of the sample characteristics.

Table 2. Sample characteristics (Research study A)

Portfolio Level (N=100 portfolios)					
Revenue		Employees		Portfolio Budget	
<100 Mill. EUR	17%	<500	29%	<10 Mill. EUR	22%
100-500 Mill. EUR	20%	500-2000	30%	10-30 Mill. EUR	24%
501-2000 Mill. EUR	26%	>2000	41%	30-100 Mill. EUR	26%
>2000 Mill. EUR	37%			>100 Mill. EUR	28%

Project Level (n=378 projects)			
Project Budget		Project Duration	
<200k EUR	14%	< 1 year	20%
200-500k EUR	19%	1-2 years	48%
501-2000k EUR	23%	2-3 years	16%
>2000k EUR	44%	> 3 years	16%

2.4.2 Measurement

This study's variables were measured with multi-item scales derived from previous literature. The informants rated the constructs on seven-point Likert scales ranging from 1 ("strongly disagree") to 7 ("strongly agree"). We validated reflective items using principal components factor analysis (PCFA) followed by confirmatory factor analysis (CFA) (Ahire and Devaraj, 2001; Podsakoff et al., 2003). To determine scale reliability, we used Cronbach's Alpha and Composite Reliability following previous recommendations (Ahire and Devaraj, 2001). We assessed discriminant validity using the Fornell-Larcker criterion, which was fulfilled for all constructs. Cut-off criteria were taken from Hu and Bentler (1998) to evaluate the structural equation models. Because data were collected on the project and the portfolio level, we conducted two different CFAs. The CFA on the portfolio level ($\chi^2[df = 278] = 448.50$; $RMSEA = 0.068$; $SRMR = 0.070$; $CFI = 0.919$) and the CFA on the project level ($\chi^2[df = 125] = 324.31$; $RMSEA = 0.065$; $SRMR = 0.056$; $CFI = 0.934$) both had a good fit. All item wordings are shown Table 3.

Table 3. Measurement (Research Study A)

Construct	Items	λ	α	AVE	CR
Project-Level					
Teamwork Quality	Project team members communicated frequently and openly with each other.	.68	.85	.50	.85
Informant: Project Manager	Within the project team, work packages and tasks were well coordinated.	.66			
Source: (Hoegl and Gemuenden, 2001)	Strengths and weaknesses of individuals were respected in the project team.	.70			
	Within the project team, members were willing to support each other.	.80			
	Project team members did their best to fulfil their task.	.68			
	Project team members were proud to work on this project.	.70			
Project Success	The product/project result achieved…		.91	.78	.92
Informant: Project Manager	...the planned market goals (e.g., market share).	.79			
Source: (Gemünden et al., 2005)	...the planned profitability goals (e.g., ROI).	.97			
	...the planned payback period.	.89			
Team Autonomy	The project team …		.64	.43	.68
Informant: Project Manager	...had control over what they were supposed to accomplish.	.48			
Source: (Gemünden et al., 2005)	...was granted autonomy on how to handle scope changes.	.90			
	...was free to assign personnel to the project.	.50			
Project Team Diversity	The members of the project team varied in their functional backgrounds.	.80	.78	.55	.78
Informant: Project Manager	The members of the project team had expertise in different areas.	.58			
Source: (Lee and Xia, 2010)	The members of the project team had a variety of different experiences.	.82			
Technological Project Innovativeness	At the beginning of the project we did not have the necessary technical knowledge.	.81	.87	.69	.87
Informant: Project Manager	At the beginning of the project we had little practical experience in the application of the required technology.	.92			
Source: (Nguyen et al., 2018)	In our project, we could only partially rely on the existing technological competence of the company.	.76			
Portfolio-Level					
BC Existence	All projects must have a business case in order to enter the selection process.	.89	.86	.65	.85
Informant: Coordinator	"Must-Projects" (mandatory projects) also require a business case.	.83			
Source: (Kopmann et al., 2015)	We intensively examine the business case when structuring our portfolio.	.70			

Strategic Clarity	We have a written mission, long-term goals and strategies to achieve them.	.80	.88	.72	.88
Informant: Coordinator	Goals and strategies are communicated in our company.	.90			
Source: (Kock and Gemünden, 2016)	Our long-term competitive strategy is clear and understandable.	.83			
Operational control	We frequently examine the targets (e.g., strategic alignment, net return, risk) for our portfolio.	.80	.82	.62	.83
Informant: Coordinator	In our portfolio, we analytically examine plan/ actual performance deviations between planned and actual performance.	.80			
Source: (Kock and Gemünden, 2016)	We systematically analyze single projects when monitoring our portfolio.	.77			
Strategic control	We frequently review …		.91	.71	.91
Informant: Coordinator	... the feasibility of the portfolio strategy based on information acquired in projects.	.87			
Source: (Kopmann et al., 2017)	... the validity of the premises defined within strategic planning.	.87			
	... whether the strategy of the project portfolio remains justified in light of changed conditions.	.90			
	Based on the information gained in our projects we deliberately challenge the portfolio strategy.	.73			
External Turbulences	In our industry, it is difficult to predict how customers' needs and requirements will evolve.	.35	.77	.46	.77
Informant: Decision Maker	In our kind of business, customers' product preferences change quite a bit over time.	.52			
Source: (Sethi and Iqbal, 2008)	The technology in our industry is changing rapidly.	.82			
	There are frequent technological breakthroughs in our industry.	.94			
	Technological changes provide big opportunities in our industry.	.61			
Formalization	Essential project decisions are made within clearly defined portfolio meetings.	.79	.93	.77	.93
Informant: Coordinator	Our project portfolio management process is divided in clearly defined phases.	.81			
Source: (Teller et al., 2012)	Our process for project portfolio management is clearly specified.	.93			
	Overall, we execute our project portfolio management process in a well-structured manner.	.97			

Innovation Culture	In our organization, …	.83	.57	.84
Informant: Coordinator and Project Manager	... employees are given sufficient responsibility, resources, and freedom to work independently.	.70		
Source: (Kock and Gemünden, 2016)	... communication is open, meaning that we share information and appreciate debates and diverse opinions.	.70		
	... we emphasize creativity and innovativeness.	.83		
	... unconventional ideas are encouraged by management.	.78		

Project success ($\alpha = 0.914$) was measured with a three-item scale (planned market and profitability goals, planned payback period) taken from previous literature (Gemünden et al., 2005; Kock et al., 2011). Project managers assessed this variable.

Project managers assessed *teamwork quality* ($\alpha = 0.848$) with a six-item construct from Hoegl and Gemuenden (2001) using one item per dimension: communication, coordination, balance of member contributions, mutual support, effort, and cohesion.

Agile practice intensity was operationalized with three items that each assess one of the essential practices underlying all agile approaches as described in the literature (Bianchi et al., 2020; Baham and Hirschheim, 2022). The project managers specified how intensively these agile practices were applied: (1) *During our project, we continuously gathered customer/user feedback*; (2) *the project was characterized by iterative planning and execution cycles; (3) we regularly presented interim results of our project (e.g., in the form of prototypes or minimum viable products*) (Kaufmann et al., 2020). Although there might be several specific practices and artifacts in different agile methods, we concentrate on the basic practices that underly all these specific methods to broadly capture agile practice intensity independent of the specific method used. The resulting construct is a composite formative rather than a reflective construct because it fulfills the definitional criteria by Jarvis et al. (2003): A change in one item of agile practices has an influence on the overall construct but does not necessarily indicate a change in the other items (i.e., the items do not necessarily need to correlate). Further, the items can have different antecedents and consequences. And lastly, excluding an item of the construct would change its overall meaning. Since these criteria apply and prior literature also differentiates between these three dimensions (Bianchi et al., 2020; Baham and Hirschheim, 2022), we build agile practice intensity as a formative construct.

Moderator Variables. Business Case existence was measured using the three-item scale of Kopmann et al. (2015) ($\alpha = 0.858$). The construct verifies if the business case is mandatory for the project portfolio selection process, even for mandatory projects, and if the business case is checked intensively within portfolio structuring. *Strategic clarity* ($\alpha = 0.877$) is the three-item scale from Kock and Gemünden (2016), examining whether the strategic goals, the competitive strategy, and the mission are clearly

communicated and understood. We used the construct *operational control* from Kock and Gemünden (2016), which provides information about controlling mechanisms on the portfolio level ($\alpha = 0.823$). *Strategic control* is a four-item construct ($\alpha = 0.913$) from Kopmann et al. (2017). Portfolio coordinators assessed the portfolio management variables.

Control variables. We controlled for several variables on the project level and the portfolio level that might affect TWQ and project success. We identified two general project control variables (team size and project manager experience) and five project control variables that directly concern agile characteristics (project innovativeness, team diversity, dedication, colocation, and autonomy). As our argumentation is based on agile routines and not on overall agile characteristics of teams, we control for these to isolate the effect of agile practices on TWQ and project success. The project manager was the informant for the project-level variables. For the general project control variables, *team size* indicates the number of team members (natural logarithm). It could be related to TWQ because collaboration is likely easier in smaller teams (Hoegl, 2005). Further, we controlled for the *experience of the project manager* (natural logarithm of years). Less experienced project managers might cause lower TWQ and, as Savelsbergh et al. (2016) investigated, lower project success.

Additionally, we added five variables that are connected to agile project management and could present alternative explanations for observed effects. First, we controlled for projects' *technological innovativeness* ($\alpha = 0.869$) from Nguyen et al. (2018), as team members in innovative projects might be more open to new management methods and be in general more motivated. Second, *team diversity* reveals information about the team composition (functional background, expertise in different areas, variety of experiences; $\alpha = 0.781$) and is also a characteristic connected with agile teams (Lee and Xia, 2010; Sweetman and Conboy, 2018). Third, *team dedication* describes the share of team members' time allocated to the project on a scale from 0 to 1. Agile team members are often full-time dedicated to a project (Dingsøyr et al., 2018) and probably build good relationships with their team colleagues (Pinto et al., 1993). Fourth, *team colocation* assesses whether team members were collocated within the same room, same building, same site, same country, or internationally. Agile teams are often collocated, which is why team members can spontaneously communicate with each other more easily than geographically distributed team members (Hinds and Mortensen, 2005). Last, we used *autonomy* to exclude this effect for the interpretation of the final findings. Autonomy is a three-item scale that captures if the project team is free in their decisions regarding project scope or human resources ($\alpha = 0.641$). While autonomy is likely positively related to TWQ and project success (Lee and Xia, 2010), the effect of diversity on TWQ is unclear because higher heterogeneity can also lead to social categorization and conflict (van Knippenberg et al., 2004).

Furthermore, we controlled for four portfolio-level context factors that were assessed by the portfolio coordinator and the decision-maker. *Portfolio size* was measured as the natural logarithm of the annual

portfolio budget in millions of euros. The *formalization* of project portfolio management was taken from Teller et al. (2012) and was slightly adapted into a four-item scale ($\alpha = 0.928$). This construct indicates the overall maturity of the portfolio management process, which likely correlates with the moderating variables (Kopmann et al., 2015; Kock and Gemünden, 2016; Kopmann et al., 2017). *Innovation culture* from Kock and Gemünden (2016) consists of four items ($\alpha = 0.862$). *External turbulences* ($\alpha = 0.767$), with the objective of capturing the pace of change in the company's environment, consists of items taken from Sethi and Iqbal (2008). Senior managers assessed this construct because they have a better overview of the firm's environment. We present the correlations and descriptives in Table 4.

We took several measures to avoid common method variance *ex-ante* and test for common method bias *ex-post*. First, the multi-informant approach combines different hierarchical levels and perspectives and, thus, reduced common method variance (Podsakoff et al., 2003). Further, we protected project managers' anonymity and assured them that their assessment was not reported back to the company's senior managers and that there were no right or wrong answers. Ex post, we applied Harman's single-factor technique. PCFAs revealed that the largest factor on the project and portfolio level only explained 23% and 29% of the variance, respectively. Additionally, two CFAs with single-factor models for all project- and portfolio-level variables showed a very poor fit. Overall, we conclude that common method bias is unlikely to have affected the results reported in the next section.

Table 4. Correlations and descriptives (Research Study A)

	Variables	M	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1)	PL Experience (ln)	2.10	0.74	1.00																
(2)	Team size (ln)	2.64	0.88	.20	1.00															
(3)	Team Diversity	5.80	1.22	.11	.28	1.00														
(4)	Project Dedication	0.44	0.28	.15	.20	.05	1.00													
(5)	Colocation	2.90	1.22	-.06	-.17	-.24	.05	1.00												
(6)	Team Autonomy	4.02	1.37	.06	.00	.05	-.02	-.07	1.00											
(7)	Project Innovativeness	4.04	1.73	.04	-.02	.09	.13	.01	-.02	1.00										
(8)	Project success	4.62	1.23	.14	.21	.19	.04	-.03	.19	-.06	1.00									
(9)	Teamwork Quality	5.47	0.93	.20	.04	.10	.19	.08	.30	-.05	.27	1.00								
(10)	Agile Practice Intensity	4.99	1.39	.14	.13	.13	.20	-.09	.25	.19	.23	.35	1.00							
(11)	Portfolio Size (ln)	3.58	1.84	.14	.18	.06	.29	-.10	.01	-.07	.14	.05	.11	1.00						
(12)	Formalization	5.01	1.57	-.13	.11	-.05	.14	.16	-.05	.08	-.04	.10	-.03	.02	1.00					
(13)	Innovation Culture	4.77	0.75	.02	.00	-.03	.17	.03	.13	-.06	.06	.19	.12	.19	.10	1.00				
(14)	External Turbulences	4.47	1.08	-.00	-.07	-.12	.02	.06	.01	.02	-.04	-.01	-.00	-.09	.20	-.11	1.00			
(15)	Strategic Control	4.05	1.30	-.09	.12	-.03	.21	.05	.04	.08	-.01	.07	.05	.11	.48	.31	.09	1.00		
(16)	Operational Control	4.39	1.37	-.03	.11	.04	.29	.08	.03	.09	-.00	.14	.04	.20	.47	.34	.02	.68	1.00	
(17)	Strategic Clarity	5.38	1.33	.06	.07	.01	.12	.06	-.01	.05	.01	.17	.05	.20	.29	.26	.17	.32	.34	1.00
(18)	BC Existence	4.76	1.58	-.00	.06	.01	.08	.04	-.03	-.09	.02	.04	-.07	.16	.16	.15	-.09	.26	.33	.09

N (project portfolios) = 100; n (projects) = 378; M = mean; SD = standard deviation; PL = Project leader; BC = Business case;
all correlations above .1 are significant at the 5%-level

2.5 Results

A two-level model is required for our analysis because the data contains projects nested in portfolios. We use random-effects regression with the portfolio as the grouping variable in order to separately account for portfolio- and project-level effects. Model 1 in Table 5 shows the results for the control variables only, model 2 includes the direct effect of agile practices, and the subsequent models include the interaction effects. Regarding the control variables from the portfolio level, we find that formalization and innovation culture are positively related to TWQ. At the project level, project manager experience, all four agile characteristics we controlled for (team autonomy, diversity, collocation, and dedication) all positively predict TWQ.

Hypothesis H1 argued that agile practices are beneficial for teamwork quality. The empirical results in model 2 support H1 because the unstandardized regression coefficient is positive ($b = 0.19; p = .000$).

In contrast to H3a, b, and H4a, the results show that portfolio-level contingencies actually weaken the positive effect of agile practice intensity on TWQ. We argued that the existence of business cases positively affects the relationship between agile practice intensity and TWQ (3a). However, the interaction term is negative ($b = -0.046; p = .016$). Thus, we reject Hypothesis 3a. Regarding the moderation effect of strategic clarity (H3b), the positive relationship between agile practice intensity and TWQ also decreases with increasing strategic clarity ($b = -0.043; p = .065$). Hence, strategic clarity also weakens the main relationship, and H3b has to be rejected, too. Similarly, model 5 (H4a) shows that operational control negatively moderates the relationship between agile practice intensity and TWQ ($b = -0.049; p = .024$). Therefore, we have to reject hypothesis 4a. For Hypothesis 4b, we find that the interaction with strategic control is not significant ($b = -0.013; p = .603$). Thus, we can neither accept nor reject H4b. We visualize the marginal effects of agile practice intensity on TWQ for different levels of business case existence, strategic clarity, and operational control with 90%-confidence bands in Figure 2. The influence of agile practices on TWQ decreases with increasing levels of all three contingency factors. For a sufficiently high degree of business case existence, strategic clarity, or operational control, the effect is zero.

Finally, model 8 shows the direct relationship between teamwork quality and project success, which is positive ($b = 0.245; p = .001$). However, agile practices also show a positive residual coefficient ($b = 0.104; p = .034$), which suggests a partial mediation. To identify the indirect effect of agile practice intensity on project success through its influence on TWQ moderated by the three significant interaction terms, we followed the approach suggested by Hayes and Preacher (2014) and bootstrapped the results with 5,000 repetitions. The marginal indirect effects of agile practice intensity through TWQ on project success are shown in Figure 2 for each significant moderation. The results reveal a significant indirect effect that decreases with increasing portfolio contingencies, which supports hypothesis 2. The indirect

effects remain significant up to a value of business case existence = 6.3, strategic clarity = 6.7, and operational control = 5.8.

We ran supplementary analyses to rule out that our results are only valid for companies in dynamic environments or in highly innovative project portfolios. In addition to including external turbulences as a control variable, we tested the interaction term between external turbulences and agile practices on TWQ, which is insignificant ($b = 0.037$; $p = .234$). Additionally, we tested the innovativeness of the portfolio as moderator, which also stayed insignificant ($b = -0.026$; $p = .384$).

Table 5. Regression results (Research study A)

	Teamwork Quality (TWQ)								Project Success			
	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
Portfolio-Level Controls																
Formalization	0.06+	[.07]	0.07*	[.04]	0.07*	[.03]	0.06+	[.05]	0.07*	[.03]	0.07*	[.03]	-0.01	[.76]	-0.03	[.59]
External Turbulence	-0.03	[.46]	-0.04	[.37]	-0.04	[.28]	-0.03	[.42]	-0.04	[.36]	-0.04	[.36]	0.00	[.97]	0.01	[.91]
Innovation Culture	0.12+	[.07]	0.09	[.15]	0.09	[.13]	0.09	[.15]	0.09	[.14]	0.09	[.16]	0.06	[.52]	0.01	[.88]
Portfolio size (ln)	-0.03	[.27]	-0.04	[.14]	-0.04	[.11]	-0.04	[.14]	-0.04	[.15]	-0.04	[.14]	0.07*	[.05]	0.07*	[.04]
Project Innovativeness	-0.05+	[.07]	-0.07**	[.00]	-0.07**	[.00]	-0.07**	[.00]	-0.07**	[.01]	-0.07**	[.00]	-0.04	[.33]	-0.04	[.29]
Project-Level Controls																
Project Leader Experience (ln)	0.22**	[.00]	0.20**	[.00]	0.19**	[.00]	0.19**	[.00]	0.20**	[.00]	0.20**	[.00]	0.12	[.17]	0.05	[.54]
Team Size (ln)	-0.06	[.28]	-0.08	[.13]	-0.07	[.15]	-0.08	[.12]	-0.08	[.14]	-0.08	[.13]	0.22**	[.00]	0.22**	[.00]
Team Diversity	0.08*	[.03]	0.07+	[.05]	0.07+	[.06]	0.07+	[.05]	0.06+	[.10]	0.07+	[.05]	0.15**	[.00]	0.13*	[.02]
Team Dedication	0.53**	[.00]	0.39*	[.02]	0.40*	[.01]	0.41*	[.01]	0.39*	[.02]	0.39*	[.02]	-0.09	[.71]	-0.29	[.22]
Team Colocation	0.07+	[.06]	0.08*	[.03]	0.08*	[.03]	0.08*	[.03]	0.08*	[.04]	0.08*	[.03]	0.06	[.23]	0.05	[.32]
Team Autonomy	0.19**	[.00]	0.15**	[.00]	0.15**	[.00]	0.15**	[.00]	0.15**	[.00]	0.15**	[.00]	0.16**	[.00]	0.09+	[.06]
Moderators																
BC Existence	0.00	[.92]	0.01	[.79]	0.25*	[.02]	0.01	[.67]	0.01	[.64]	0.01	[.72]	0.00	[.94]	0.01	[.82]
Strategic Clarity	0.08*	[.02]	0.08*	[.02]	0.09*	[.01]	0.30*	[.02]	0.09*	[.01]	0.08*	[.02]	-0.01	[.82]	-0.03	[.52]
Operational Control	0.03	[.56]	0.03	[.44]	0.03	[.44]	0.04	[.36]	0.28*	[.02]	0.04	[.43]	-0.04	[.52]	-0.05	[.48]
Strategic Control	-0.06	[.24]	-0.06	[.19]	-0.06	[.17]	-0.06	[.18]	-0.06	[.16]	0.00	[1.0]	0.01	[.94]	0.02	[.80]
Hypothesized Effects																
Agile Practice Intensity			0.19**	[.00]	0.20**	[.00]	0.19**	[.00]	0.19**	[.00]	0.19**	[.00]			0.10*	[.03]
Agile x BC Existence					-0.05*	[.02]										
Agile x Strategic Clarity							-0.04+	[.07]								
Agile x Operational Control									-0.05*	[.03]						
Agile x Strategic control											-0.01	[.61]				
TWQ															0.25**	[.00]
Constant	3.01**	[.00]	2.73**	[.00]	3.71**	[.00]	2.72**	[.00]	2.71**	[.00]	2.73**	[.00]	1.77**	[.00]	0.87	[.27]
R^2 (within)	0.14		0.23		0.24		0.24		0.24		0.23		0.04		0.11	
R^2 (overall)	0.22		0.29		0.30		0.29		0.30		0.29		0.12		0.17	
R^2 (between)	0.48		0.48		0.49		0.48		0.50		0.48		0.35		0.33	

Random effects GLS regression; N (project portfolios) = 100; n (projects) = 378; unstandardized regression coefficients are reported; interaction variables were mean-centered; + > 0.1; ∗p < 0.05; ∗ ∗p < 0.01; p-value in brackets; Agile = Agile Practice Intensity

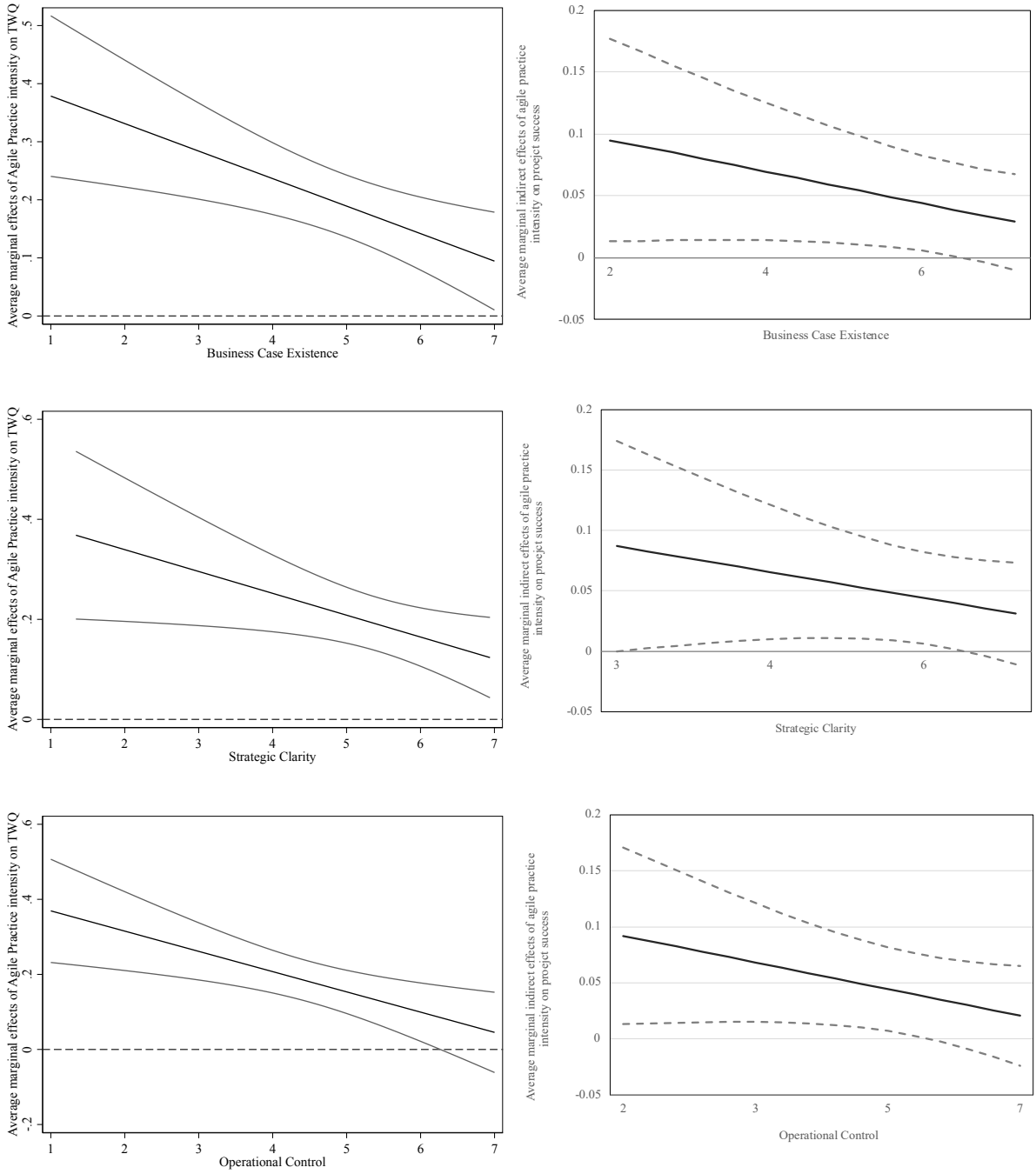

Figure 2. (Left) Marginal effects of Agile Practice Intensity on TWQ in respect of different levels of business case existence, strategic clarity, and operational control (thin lines represent a 90% confidence band); (Right) Marginal effects of Agile Practice Intensity on Project Success (dashed lines represent a 90% confidence band) (Research Study A)

2.6 Discussion

2.6.1 Theoretical Implications

This study aimed to empirically investigate how the relationship between agile practice intensity and project success is mediated by TWQ while considering portfolio-level contingencies. With our study, we make three primary contributions to research.

First, we extend the research on team processes in agile project management by using the well-established six dimensions of TWQ as our main measurement for collaboration (Hoegl and Gemuenden, 2001; Hoegl and Proserpio, 2004; Hoegl et al., 2004). So far, only qualitative studies, with the exception of Lindsjørn et al. (2016), have examined collaborative team processes in agile teams (Moe et al., 2008; Moe et al., 2010; Hoda et al., 2012; Dingsøyr et al., 2018; Bäcklander, 2019). With our study, we quantitatively demonstrate TWQ's mediating role in the relationship between agile practices and project success (Hoda et al., 2012; Hoda and Murugesan, 2016; Dingsøyr et al., 2018). We found a partial mediation, suggesting that agile practices can also benefit project outcomes beyond their effect through TWQ. For example, agile teams regularly present prototypes to users, who then provide feedback. This early involvement and regular consultation of customers might improve the product also beyond benefitting a team's collaboration (Bianchi et al., 2020). Overall, our study provides valuable quantitative insights to research on agile project management (Moe et al., 2008; Moe et al., 2010; Hoda et al., 2012; Dingsøyr et al., 2018; Bäcklander, 2019), especially agile teams' behavior (Moe et al., 2010; Dingsøyr et al., 2018; Marnewick and Marnewick, 2019).

Second, this study shows the performance relevance of agile practices' key elements in a context beyond software development. Prior research conducted agile project team studies only for software development teams (Serrador and Pinto, 2015; Lindsjørn et al., 2016). We extend this research with a broad cross-industry sample of different portfolio and project types. The results demonstrate that agile practices' core principles are transferable to non-software project management and show similar benefits for performance in that setting. A recent study by Baham and Hirschheim (2022) emphasizes four facets of agile methods that are in line with our conceptualization. Their fourth dimension incorporates close communication and cooperation. However, in their argumentation, they also elaborate that the iterative working structures and the close collaboration with customers lead to collaboration. Bianchi et al. (2020) identified sprints, feedback, and specifications as key factors for agile software development projects. We contribute to their research on finding the key elements that agile methods have in common and transfer these elements to the non-software project management literature.

Third, we embed agile practices in the PPM context and shed light on portfolio contingency factors that constrain the beneficial influences of agile practice intensity on TWQ in projects. By applying

contingency theory (Donaldson, 2001), we identified management characteristics along the PPM process that determine the context for the project level. We found out that agile practices do not fit in every portfolio management context or that the contingent environment needs to change when organizations decide on agile management approaches in their projects. Therefore, we expand contingency theory in project management that, so far, only considered single projects' characteristics as contingencies on the project level (Shenhar, 2001) or portfolio characteristics as contingencies on the portfolio level (Teller et al., 2012). We contribute to this research by applying project portfolio characteristics as contingencies for the project level, specifically agile project management. This answers the call for more context-specific PPM research (Martinsuo, 2013) and adds empirical evidence to the sparse multi-level research between portfolios and projects (Martinsuo and Lehtonen, 2007; Teller et al., 2012; Nguyen et al., 2018).

We initially proposed that business case existence, strategic clarity, strategic control, and operational control strengthen the relationship between agile practices and TWQ. However, we found negative moderation effects of business case existence, strategic clarity, and operational control. One explanation could be that these portfolio-level practices, despite their positive effects on the overall portfolio, limit the freedom and creativity of agile teams (Kopmann et al., 2015; Hennel and Rosenkranz, 2021). Since creativity is necessary for problem-solving in agile practices, standardization through portfolio management practices, for example, strategic control or business case existence, may hinder agile project teams from using their routines and practices to fulfill their goals. This can lead to conflicts within the team. Measuring agile projects' goals and their impact on the entire portfolio is often difficult using conventional indicators (Serrador and Pinto, 2015). Sweetman and Conboy (2018) argue that project portfolio complexity increases when significant parts of the portfolio consist of agile projects. Since agile projects strive to achieve high customer satisfaction (Dyba and Dingsoyr, 2008; Serrador and Pinto, 2015), it is difficult for agile projects to prioritize between customer requirements and the company's strategy (Sweetman and Conboy, 2018). Deciding which stakeholder's objective to prioritize can lead to stress for team members, who may have diverging opinions concerning this choice. For these reasons, agile teams may ignore the portfolio's common purpose (Lappi et al., 2018).

Additionally, our results imply that traditional, prevalent PPM methods and, eventually, the PPM process need adjustment when organizations integrate agile projects into the portfolio. Many companies already try to apply agile practices at the portfolio level. One widely used approach is the Scaled Agile Framework (SAFe) by Leffingwell (2007) or frameworks that have been developed by Krebs (2009) or Vähäniitty (2012). Agile PPM can help to adapt portfolio processes to the iterative nature of agile practices. However, as Stettina and Horz (2015) found out, firms still struggle to scale agile methods at the portfolio level after initiating agile methods in individual projects and most firms still simultaneously use agile and traditional project management methods in one traditionally managed project portfolio. Therefore, our findings are important and support former research that when

implementing agile practices, the organization needs to be committed to agile practices and might scale agile practices beyond the project level.

By investigating these interaction effects of portfolio-level practices, we contribute to the literature on PPM and on agile project teams who operate in non-agile or hybrid environments by demonstrating possible barriers in the form of contingency factors. Thus, we answer the call for research on the interaction between project and portfolio management practices in general (Martinsuo and Lehtonen, 2007; Nguyen et al., 2018), and, specifically, agile practices (Moe et al., 2010; Sweetman and Conboy, 2018; Kaufmann et al., 2020).

2.6.2 Managerial Implications

This study's findings suggest for practitioners that teams enhance their cooperation, communication, and cohesion when they use agile methods. Managers can profit from this study by evaluating agile practices in their respective contexts. The use of agile practices in terms of iterative planning and execution cycles, continuous customer feedback, and minimum viable products enhances team-internal collaboration and success, also for non-software projects. Even if managers choose not to use agile methods explicitly, they can learn from their routines and implement parts of them in traditionally managed projects.

Furthermore, organizational contingencies on the portfolio level, such as operational control, business case existence, and strategic clarity, weaken this relationship. Decision-makers should be careful when introducing agile practices to an otherwise traditionally managed project portfolio. In strongly controlled portfolios, agile practices might be less valuable. Managers should be aware requirements of agile and traditionally managed projects differ not only at the project level but also in relation to the overall portfolio. However, well-established routines, for example business cases, should be adopted where appropriate by using other approaches that are designed for agile projects (e.g., planning poker).

2.6.3 Limitations and Future Research

The results should be interpreted in light of the study's limitations. First, the data were collected using a cross-sectional survey and therefore provide only correlational evidence. Although we tried to rule out alternative explanations through portfolio- and project-level controls and address common method bias through multiple informants, the results do not imply causality. For example, it might be that teams with higher TWQ more likely adapt to new working methods, such as agile practices.

Second, we investigated contingency factors that influence the relationship between agile practices and agile projects' teamwork. However, future research should address which part of the portfolio management process firms need to adapt most when including agile projects in an otherwise traditionally managed portfolio. We think it is important to adapt phases of the process or routines for

agile projects to be successful (Hobbs and Petit, 2017; Sweetman and Conboy, 2018). In this regard, a longitudinal research approach of project portfolios and their project teams introducing agile practices could deliver interesting insights.

Third, while we identified important contingency factors along the portfolio process, additional contingencies could influence the relationship between agile practices, teamwork, and project success. For example, the entrepreneurial orientation or a company's innovation climate can affect the relationship between agile practices and teamwork because these factors can enhance agile teams' freedom and autonomy. Also, investigating different portfolio types could shed more light on the importance of agile practices and contingency factors in different portfolios (e.g., R&D or construction portfolios).

Lastly, we focused on project business success to demonstrate the relevance of the relationship between TWQ and agile practice intensity. However, there are further dimensions of project success, such as learning success or customer satisfaction (Shenhar et al., 2001). It remains unclear whether agile practices pay off across all dimensions (Bianchi et al., 2020; Gemino et al., 2020; Copola Azenha et al., 2021). Especially the performance comparison of a mixed project portfolio of traditional, hybrid, and agile projects calls for a multidimensional approach of project success. Future research could investigate this issue with a qualitative research approach to investigate how companies compare project success between traditionally managed and agile projects.

Chapter 3 Research Study B:
The Interplay between Dynamic Capabilities' Dimensions and Their Relationship to Project Portfolio Agility and Success

Abstract:

Recent literature emphasizes agility's importance for a project portfolio's success in a dynamic environment. Conceptually, dynamic capabilities should be relevant antecedents for portfolio agility since they help organizations cope with dynamic environments. Dynamic capabilities disaggregate into three dimensions: *sensing* market and technology opportunities, *seizing* opportunities through prioritizing and exploiting them, and continuously *reconfiguring* assets and structures. Although previous literature emphasizes the importance of dynamic capabilities for project portfolio management (PPM), former research rarely analyzed dynamic capabilities in PPM empirically. Further, dynamic capabilities can be conceptualized differently, and it remains unclear how different conceptualizations coexist and what effects they have on the results of a study. This paper quantitatively investigates the relationship between dynamic capabilities' dimensions (sensing, seizing, and reconfiguring) and project portfolio agility and success using a multi-informant, cross-industry sample of 135 project portfolios. The findings show that dynamic capabilities positively relate to portfolio agility and that portfolio agility mediates the relationship between dynamic capabilities and portfolio success. Surprisingly, sensing, seizing, and reconfiguring do not have entirely complementary effects. Instead, at least two of the three dimensions must be strongly present to enhance portfolio agility positively. The study underscores the importance of dynamic capabilities for portfolio agility. It contributes to the literature on portfolio agility in PPM and a more differentiated view of dynamic capabilities' dimensions and their consequences.

Classification in terms of this dissertation:

- **Tensions:** Being agile while at the same time keeping the portfolio strategically aligned and utilizing the resources efficiently
- **Sample:** Multi-informant project portfolio management survey (n=135 portfolios)
- **Method:** Structural equation modeling and hierarchical regression with 135 portfolios

Publication:

Bechtel, Jadena; Kaufmann, Carsten; Kock, Alexander (2022): The Interplay between Dynamic Capabilities' Dimensions and Their Relationship to Project Portfolio Agility and Success. In: *International Journal of Project Management*. DOI: 10.1016/j.ijproman.2023.102469.

An earlier version was presented at the International Product Development Management Conference 2021, online, and received the *Runner-Up Thomas Hustad Best Student Paper Award.*

3.1 Introduction

The primary objective of project portfolio management (PPM) is to evaluate and select projects aligned with an organization's strategy under consideration of its scarce resources to achieve short-term and long-term success (Cooper et al., 2001; Martinsuo, 2013). However, changing technologies, customer needs, or competitive conditions require managers to adapt their project portfolio to changing conditions quickly (Kester et al., 2011; Kester et al., 2014; Kock and Gemünden, 2016; Roth et al., 2019; Martinsuo and Geraldi, 2020). Accordingly, agility—the degree to which portfolio management can quickly adapt the portfolio—is a critical success factor for project portfolios (Kester et al., 2014). It enables portfolio management to shift resources rapidly toward more promising projects (Hansen and Svejvig, 2022). Even though portfolio agility is essential for project portfolios and moved into focus within the last decade, processual antecedents that lead to portfolio agility have rarely been investigated in PPM (Kock and Gemünden, 2016). Yet, firms contend with being agile while at the same time keeping their portfolio strategically aligned and utilizing their resources efficiently (Hoffmann et al., 2020; Muruganandan et al., 2022).

Dynamic capabilities might constitute relevant antecedents for portfolio agility since they help organizations cope with dynamic environments (Teece et al., 1997; Helfat et al., 2009). While the resource-based view focuses on building capabilities in stable environments (Barney, 1991), dynamic capabilities enable organizations to challenge their resources regularly and rapidly exploit new ones if needed (Teece, 2007). Organizations that build dynamic capabilities gain competitive advantages and are more successful (Wilden et al., 2013; Schilke, 2014; Fainshmidt et al., 2016). Teece (2007) defines dynamic capabilities using three processual dimensions: *sensing* means identifying changes within the environment and, hence, new opportunities to innovate; *seizing* means exploiting these opportunities; and *reconfiguring* means adapting the organization's resources if the company needs to change. This typology of processual dimensions is the most prominent used in research. However, the literature's conceptualization of dynamic capabilities varies depending on application areas and research domains (Schilke et al., 2018). Researchers operationalize Teece's (2007) typology differently: dynamic capabilities as an overall second-order construct (Tanriverdi and Venkatraman, 2005) or as a multi-dimensional construct whose first-order dimensions have individual effects (Schilke, 2014). Both conceptualizations have limitations as they do not enable reasoning changes in the outcome that might stem from covariations in sensing, seizing, and reconfiguring. Former literature argued in the case of other multi-dimensional constructs (e.g., entrepreneurial orientation) that "[a]s both conceptualizations are unquestionably legitimate (…), it is not a matter of which conceptualization is correct or incorrect, but, rather, how these perspectives can coexist or even be combined" (Lomberg et al., 2017, p. 974). Further, Schilke et al. (2018) emphasized the need to conceptualize the processual dimensions individually and investigate their interactions. Therefore, a quantitative study examining the

interactions among the three dimensions of dynamic capabilities is necessary to understand their performance effects.

Previous literature has already applied a dynamic capability lens to project portfolio management identifying PPM itself as a dynamic capability (Killen and Hunt, 2010; Petit, 2012; Kock and Gemünden, 2016). Researchers indicate that implications remain superficial when using a second-order dynamic capability for PPM (Daniel et al., 2014). So far, only qualitative (Petit, 2012) and conceptual studies (Killen et al., 2012) have investigated the multi-dimensional nature of dynamic capabilities in PPM. The few quantitative studies that evoked dynamic capabilities did not directly operationalize them (Killen and Hunt, 2010; Kock and Gemünden, 2016). Furthermore, there is a call for further research on mediating mechanisms between dynamic capabilities and performance outcomes (Wilden et al., 2013; Schilke et al., 2018). Thus, a quantitative study on the multi-dimensional nature of dynamic capabilities could shed light on how they contribute to portfolio agility and, ultimately, to portfolio success, explaining how firms become flexible yet remain efficient (Hoffmann et al., 2020).

This study addresses this research gap and empirically investigates the relationship between dynamic capabilities, portfolio agility, and portfolio success. We formulate our research question: *How does the interplay of dynamic capabilities' dimensions of sensing, seizing, and reconfiguring relate to project portfolio agility and, eventually, success?*

We chose the dynamic capabilities framework from Teece (2007) because it fits well with the dynamic PPM process (Petit, 2012). Besides, Teece et al. (2016) argue that dynamic capabilities support the efficient use of agility in highly uncertain environments. We hypothesize that the *complementarity* of dynamic capabilities' sensing, seizing, and reconfiguring increases portfolio agility, which then enhances portfolio success. Higher portfolio agility can lead to a successful portfolio and a competitive advantage (Kester et al., 2011). Through a dynamic PPM process, decision-makers and portfolio managers should be able to better adapt the project portfolio to changing boundary conditions.

We tested our hypotheses on a cross-industry survey sample of 135 project portfolios in medium to large-sized firms using two informants for each portfolio (a decision maker and a coordinator). Hierarchical regression shows that dynamic capabilities positively relate to portfolio success mediated by agility. Further, sensing, seizing, and reconfiguring interact with each other but, surprisingly, not entirely complementarily. Instead, at least two of the three dimensions must be strongly present to affect portfolio agility positively.

This study contributes to the literature on PPM, especially portfolio agility (Kester et al., 2014; Kock and Gemünden, 2016; Hoffmann et al., 2020), and the overall literature on dynamic capabilities in project studies (Petit, 2012; Davies and Brady, 2016). First, we add relevant insights to the literature on dynamic capabilities and agility by empirically demonstrating the positive relationship between dynamic capabilities as a second-order construct and portfolio success mediated through portfolio

agility (Overby et al., 2006; Teece et al., 2016; Kaufmann et al., 2020; Hoonsopon and Puriwat, 2021). Second, we contribute to a more differentiated view of dynamic capabilities' dimensions. Our study offers more granular insights into their impact, contrasting the current popularity of meta-analyses that promote dynamic capabilities only as one construct (Fainshmidt et al., 2016; Bitencourt et al., 2020; Leiringer and Zhang, 2021). We demonstrate that the dimensions reveal a more complex relationship between each other beyond being complementary. Third, we add to the prominent view that the external context is relevant in project portfolio decision-making (Killen et al., 2012; Martinsuo and Geraldi, 2020). Portfolios need to adapt to changing internal and external conditions to remain successful. Dynamic capabilities constitute a relevant antecedent recognizing changes in external and internal conditions. Finally, we draw attention to the simultaneous awareness of all three dimensions of dynamic capabilities and encourage decision-makers and portfolio managers to invest in dynamic capabilities where appropriate.

3.2 Theoretical Framework

3.2.1 Dynamic capabilities and their contribution to performance

"A dynamic capability is the capacity of an organization to purposefully create, extend, or modify its resource base" (Helfat et al., 2009, p. 1). Building on the resource-based view (RBV) by Barney (1991) and Wernerfelt (1984), the dynamic capability framework argues that firms in increasingly dynamic environments need to not only possess resources but also adapt those resources (if necessary) to gain a long-term competitive advantage (Teece, 2007). Priem and Butler (2001) criticized the RBV because the definitional bases of resources are too generic and do not explain *how* resources are applied to gain competitive advantage, concluding that the RBV is only valuable for static environments. Dynamic capabilities try to fill this 'black box' by explaining the underlying processes that lead to the successful adaptation of resources, which are synonymous with strategic change, and, consequently, competitive advantage (Teece et al., 1997; Eisenhardt and Martin, 2000; Fainshmidt et al., 2018). Schilke et al. (2018) conducted a literature review where they constitute different firm consequences resulting from dynamic capabilities' influence. In addition to conventional metrics such as financial performance and competitive advantage, the researchers discerned higher flexibility, survival, and growth as consequences due to dynamic capabilities enhancing an organization's capacity to respond to environmental dynamism. Accordingly, many studies investigate the role of dynamic capabilities for firm performance under environmental turbulence. A meta-analysis shows that dynamic capabilities (beyond ordinary capabilities) positively relate to performance and that environmental turbulences strengthen this relationship (Karna et al., 2016).

Teece (2007) divides dynamic capabilities into three dimensions: sensing, seizing, and reconfiguration. *Sensing* means that firms scan their business environment for market and technological opportunities. The organization needs to fulfil several requirements to excel in opportunity identification. For example, performing sensing well requires the organization to thoroughly understand customer needs, technology, and possible industry stakeholders (Teece, 2007). *Seizing* means that firms prioritize and exploit identified opportunities. Seizing could mean deciding on technological specifications, changes in business models, or implemented processes. Therefore, sensing and seizing capacity share similarities with exploration and exploitation. While exploration, comparable to sensing, "does not necessarily involve large commitments of resources" (Teece, 2007, p. 1343), exploitation refers to the actual implementation of identified opportunities, which is resource-consuming. By exploiting more innovations, the organization and its assets naturally grow. Thus, organizations need to *reconfigure* their structures and processes continuously.

3.2.2 PPM as a dynamic capability

A firm's project portfolio comprises projects competing for the organization's scarce resources (Cooper et al., 2001). Project portfolio management is a decision-making process about those resources while at the same time evaluating, selecting, and prioritizing the right projects that are crucial for the portfolio's success (Martinsuo, 2013; Kaufmann et al., 2021). Kock and Gemünden (2016) demonstrated that a transparent strategy, a formalized portfolio process, continuous portfolio monitoring, realistic handling of risks, and an innovation-supporting culture increase the quality of this decision-making process. PPM aims to maximize the portfolio projects' value, align projects with a company's strategy, and achieve an overall balanced selection of projects (Jonas et al., 2013; Kester et al., 2014). Project portfolios are crucial for companies as companies allocate a significant portion of their budget to them. Further, they play a key role in implementing a company's strategy (Hansen and Svejvig, 2022).

In project studies, many researchers rely on the concept of dynamic capabilities when investigating the identification or development of organizational capabilities (Leiringer and Zhang, 2021). Schilke et al. (2018, p. 405) suggest “to select appropriate outcome variables that are sufficiently close to a study’s focal type of capability”. Through dynamic capabilities, portfolios can better diffuse their learnings from previous projects, leading to better alignment of their resources. Further, innovation activities in portfolios benefit from dynamic capabilities to better react to the “requirements and opportunities” of the external environment (Keinz et al., 2021, p. 98). Additionally, Teece’s (2007) dimensions constitute relevant antecedents for a portfolio’s innovation activities and are interrelated (Steen et al., 2021).

Therefore, dynamic capabilities are suitable for characterizing PPM (Kock et al., 2015; Davies and Brady, 2016). Killen et al. (2012) link the PPM process to dynamic capabilities. Here, sensing, seizing, and reconfiguring fit and is aligned with the PPM decision-making process of structuring and steering the projects. Whereas seizing reflects selecting projects (structuring), reconfiguring optimizes the PPM

process and its resources continuously (steering). It is recommended to undertake sensing activities throughout the PPM process. Scholars investigated qualitatively how firms build dynamic capabilities for IT portfolios and how they improve portfolio success (Daniel et al., 2014). They saw dynamic capabilities as abilities enabling the IT portfolios to apply, for example, correct prioritization criteria. Additionally, Petit (2012) and Martinsuo et al. (2014) recommend applying the dynamic capability framework and its dimensions of sensing, seizing, and reconfiguring to portfolio management research, as it is well-suited to study portfolio processes in highly uncertain environments.

Besides, project capabilities, as introduced by Davies and Brady (2000, p. 951), "refer to management organisation, processes and procedures required to be successful […] in completing projects within budget, on schedule and to unique customer specifications." Clearly differentiating the concepts of project and dynamic capabilities is not possible. However, many approaches state that project capabilities reside at a lower operational level and dynamic capabilities at a higher strategic level and that they interrelate with each other (i.e., dynamic capabilities actively capture and adjust project capabilities) (Davies and Brady, 2016; Leiringer and Zhang, 2021). Scholars also emphasize that project capabilities aggregate to dynamic capabilities on an organizational level (Melo et al., 2021).

Managing multiple interdependent projects in a portfolio requires quickly reacting to changing technologies, customer needs, or competitive conditions (Kester et al., 2014; Kock and Gemünden, 2016; Roth et al., 2019). Especially in an innovation context, firms must build competencies for radical innovation to identify trends and possible new partners (sensing) (Guertler and Sick, 2021). For well-established companies, this might be particularly difficult to realize (Teece, 2007).

This is where dynamic capabilities support companies in "balancing stability and change, while responding flexibly to changing conditions" (Muruganandan et al., 2022, p. 608). By forming dynamic capabilities, firms pick up the pace and become adaptive (Keinz et al., 2021). Therefore, portfolio management research used the theory of dynamic capabilities to explain how portfolios develop agility (Hansen and Svejvig, 2022).

3.2.3 Project Portfolio Agility

Project portfolio agility shares similarities with organizational agility. Teece et al. (2016, p. 17) describe organizational agility "as the capacity of an organization to efficiently and effectively redeploy/ redirect its resources to value-creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant," which is comparable to the term flexibility or adaptiveness. Many conceptualizations of organizational agility exist, depending on the theoretical foundation and research field (see Tallon et al., 2019). We distinguish agility from agile practices that evolved from software development (Fowler and Highsmith, 2001). Agile practices, characterized by iterative planning and execution cycles, presenting interim results, and continuously gathering customer/ user feedback, are

now used outside software development in other project management areas (Bianchi et al., 2020; Bechtel et al., 2022). In recent years, project portfolio management scaled agile practices on a higher organizational level transferring the routines and tools to portfolio processes (Leffingwell, 2010). However, in our case, portfolio agility is a behavioral construct for decision-makers to quickly adapt the project portfolio to changing customer needs, resource situations, strategic goals, and new technologies (Kock and Gemünden, 2016). This can be achieved through agile practices applied on the project or portfolio level but is not limited to this field (Kaufmann et al., 2020). Agility incorporates rapidity and flexibility, which allow portfolios to shift resources to more promising projects and terminate projects that might no longer fit the strategic goals (Kester et al., 2011; Unger et al., 2012). Therefore, agility is essential to remain or gain a competitive advantage (Kester et al., 2014). The challenge of PPM is being flexible (agile) while at the same time staying efficient with the remaining business (Hoffmann et al., 2020). Unlike the literature on information systems (Overby et al., 2006; Roberts and Grover, 2014), we argue that all three dimensions are essential for portfolio agility in PPM.

3.3 Hypotheses

3.3.1 Overview

We hypothesize that the underlying three dimensions of dynamic capabilities, sensing, seizing, and reconfiguring, positively contribute to portfolio agility—and eventually to project portfolio success—in a complementary way (Teece, 2007). We illustrate our conceptual framework in Figure 3. First, we hypothesize that portfolio agility positively relates to portfolio success (H1). Further, complementarity means that the set of dimensions (here, sensing, seizing, and reconfiguring) provides a unique strength to the firm that exceeds the effect of the individual dimensions (Tanriverdi and Venkatraman, 2005). In other words, a set of capabilities are complementary when more of any of them increases the returns in doing more of the others. Complementarity can be conceptualized in two ways. The first approach assumes a second-order construct encompassing the three dimensions as lower-order factors that coexist and covary with one another (H2a) (Tanriverdi and Venkatraman, 2005; Kale and Singh, 2007). The second approach (H2b) realizes the dimensions as independent factors that interact with each other (Kock et al., 2015), which means a three-way interaction. Former literature emphasized that by looking at interactions, we can find more detailed explanations of why an outcome changes (Lomberg et al., 2017). Therefore, it is reasonable to observe the effects of the individual dimensions and their interactions with each other. To comprehensively explore the nature of dynamic capabilities' dimensions, we apply both possibilities in hypotheses H2a and H2b, respectively. We will present our arguments in the following.

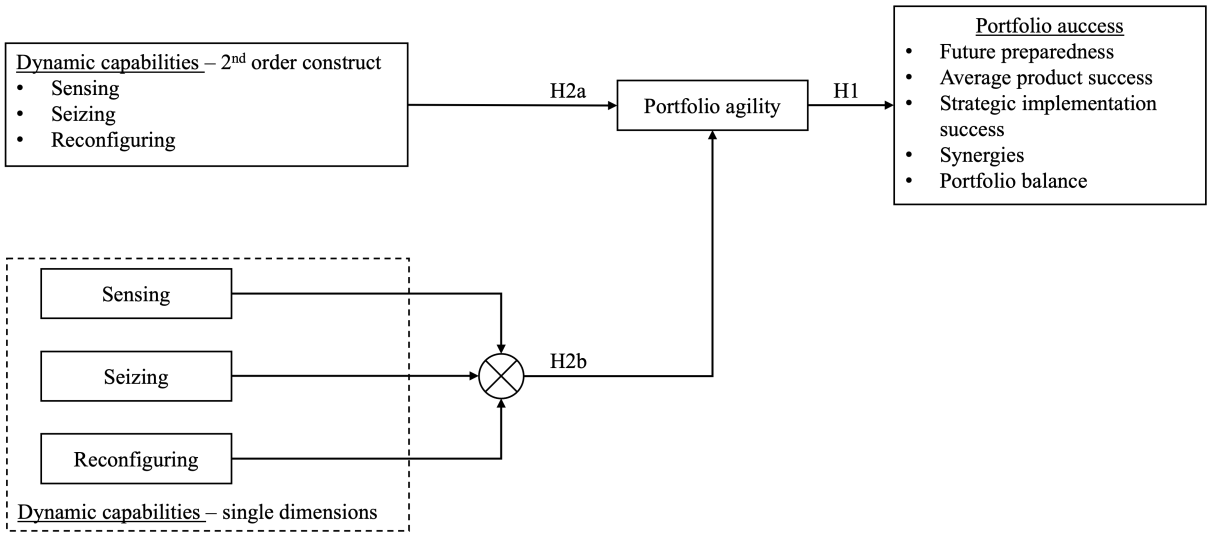

Figure 3. Conceptual framework (Research Study B)

3.3.2 Agility and Project Portfolio Success

We argue that portfolio agility improves project portfolio success. Teece (2007) mentions that continuously improving and adapting new technology can be a competitive advantage. The concept of project portfolio agility comprises four dimensions showing that PPM can adjust their project portfolio quickly to changing customer needs, resource situations, strategic goals or new technologies (Kock and Gemünden, 2016). Overby et al. (2006) argue that agility, similar to dynamic capability, is only vital in dynamic environments and not so much in relatively stable industries. Most organizations conducting PPM strive for new technologies and products to address a changing market and technology environment. Therefore, agility is likely to be advantageous for project portfolios.

Following previous literature, we conceptualize project portfolio success as a second-order construct comprising five dimensions: average product success, strategic implementation success, portfolio balance, portfolio synergies, and preparedness for the future (Kock et al., 2015; Kaufmann et al., 2021). The *average product success* reflects fulfilling the targeted goals of all products or projects that are individually defined. *Strategic implementation success* refers to the fit between the projects and the firm's strategy. A portfolio is *balanced* if it contains a good mix of more innovative yet riskier projects and projects that continue to build on the company's existing assets with lower levels of risk. *Portfolio synergies* arise through the shared use of knowledge and decrease redundancy. Synergies can be technological or market-driven and contribute to the portfolio's effective use (Meskendahl, 2010). Lastly, *preparedness for the future* describes the portfolio's long-term orientation, which is especially relevant for project portfolios. In PPM, decision-makers and portfolio managers should invest in new competencies to gain a competitive advantage in the future (Kock et al., 2015; Kaufmann et al., 2021).

Kester et al. (2014) empirically demonstrated that PPM agility positively relates to the portfolio's balance, strategic alignment, and value, explaining that companies can quickly reshuffle resources to adapt to changing environments. Kock and Gemünden (2016) reasoned that transparent and rigorous decision-making in PPM leads to a more agile portfolio. Especially inconvenient tasks, such as terminating projects, could benefit from high-quality decision-making. Prior research also finds empirical support for this relationship (Kester et al., 2014; Kock and Gemünden, 2016; Queiroz et al., 2018).

H1: Portfolio agility positively relates to portfolio success.

3.3.3 Dynamic Capabilities' Role for Portfolio Agility

Project portfolios can encounter turbulent environments (Kock and Gemünden, 2016) and often face higher levels of uncertainty and risk leading to a more dynamic decision-making process (Schultz et al., 2013) and requiring a more adaptive portfolio management approach (Petit, 2012).

In this study, we hypothesize that the dynamic capabilities of sensing, seizing, and reconfiguring positively associate with portfolio agility and, eventually, portfolio success. We argue that organizations should regularly challenge their PPM capabilities to stay adaptive by enhancing their dynamic capabilities. The sensing capability helps explore opportunities early, which enables portfolio managers and decision-makers to remain flexible in their decision-making. Seizing helps exploit promising opportunities' potential. Killen and Hunt (2010) define a range of portfolio management capabilities that connect its primary objective—efficiently and effectively using the organization's scarce resources—with dynamic capabilities. Dynamic capabilities build on experiences by "a combination of tacit and explicit learning mechanisms" (Killen and Hunt, 2010, p. 164). While the organization grows and gains experience, it needs reconfiguring to scrutinize its PPM processes regularly and adjust them if necessary.

As Heimeriks et al. (2012, p. 719) state, higher-order routines, such as dynamic capabilities, "foster ad hoc problem solving" and "counteract […] the inertial forces" from already established processes. Petit (2012) introduced Teece's (2007) dimensions in project portfolio management and argued that portfolios' internal and external environments constantly change. Therefore, portfolio managers need to align their resources with them continually. However, when establishing a capability, the firm still needs to explore long-term projects instead of exploiting incremental innovation and striving for short-term success. PPM capabilities, such as sensing project opportunities, seizing those opportunities, but also challenging/ reconfiguring PPM processes, are characteristics of the PPM process and positively contribute to portfolio agility. This ultimately leads to a competitive advantage. Agility thus acts as a

mediator between dynamic capabilities and project portfolio success. Schilke et al. (2018) noted that changes within the resource base (i.e., PPM agility) act as mediators that lead to higher performance through dynamic capabilities. Therefore, we conclude that the dynamic capability's dimensions of sensing, seizing, and reconfiguring as higher-order routines positively relate to portfolio agility. We hypothesize:

H2a: Dynamic capabilities positively relate to portfolio agility and eventually to portfolio success (mediation).

Second, we argue that the three dimensions relate to portfolio agility in a complementary way. Dynamic capabilities at the portfolio level should occur concurrently to contribute to portfolio agility effectively. Teece (2007, p. 1341) supports this argument in his seminal work: "The enterprise will need sensing, seizing, and transformational/reconfiguring capabilities to be simultaneously developed and applied for it to build and maintain competitive advantage." On the other hand, research has also proposed dynamic capabilities as a sequential process (Helfat et al., 2009). This (chrono-)logical order would imply that the firm first senses opportunities before seizing them and finally reconfigures its assets and resources. However, even if seizing follows sensing a new opportunity, the capability to be proficient at seizing should still be present at any time. Furthermore, as PPM is an ongoing process, constant questioning of the current decision-making process is crucial in dynamic environments (Kaufmann et al., 2021). Therefore, besides sensing and responding (seizing) (Overby et al., 2006; Roberts and Grover, 2014), reconfiguring is also critical in the case of PPM (Killen et al., 2012; Park et al., 2017).

In conclusion, we propose that the three dimensions complement each other in their relationship to portfolio agility. Thus:

H2b: The complementarity of sensing, seizing, and reconfiguring (three-way interaction) positively relates to portfolio agility.

3.4 Methodology

3.4.1 Sample

The unit of analysis is the project portfolio. We used a cross-industry sample of medium to large-sized firms' project portfolios to test our hypotheses. First, we contacted 750 organizations with portfolios of at least 20 simultaneously running projects. The collection of data covered a period of 6 months. For each portfolio, we addressed two informants: (1) a portfolio coordinator or manager who

had a good overview of the portfolio and its processes (typically a portfolio manager, head of the project management office, team leader of PMO division, or multi-project manager); (2) a senior management decision maker who decided on selecting, prioritizing, and terminating projects (typically division head, head of R&D, CEO, or vice president). Second, we sent the portfolio coordinators individualized online survey links via email for each role. The coordinator was responsible for distributing the links. Our respondent rate amounted to 20,9 %. We received answers from 143 portfolio coordinators and 149 portfolio decision-makers, collectively informing on 156 project portfolios. With the help of the individualized links, we matched the informants' answers to the portfolios. For eight portfolios, only the coordinator completed the survey; for 13 portfolios, only the decision maker completed the survey. Thus, the final sample consists of 135 portfolios with matching answers from decision-makers and portfolio coordinators. This two-informant design along different hierarchy levels enables us to reduce common method bias (Podsakoff et al., 2003) because coordinators assess the exogenous variables and decision-makers the endogenous variables (i.e., mediator and dependent variable). Additionally, the informant with the best informative power for the respective variable assessed it. Table 6 gives an overview of the sample characteristics (industry, employees, revenue, portfolio budget, means of dynamic capabilities, and agility by industry). While some variance may appear across sectors (e.g., the sensing dimension is higher in Electronics/IT than in Logistics), it is not systematic because an ANOVA did not show statistically significant differences between industries.

Table 6. Sample characteristics (Research Study B)

Industry		Sensing	Seizing	Reconfiguring	Portfolio agility
Automotive/ Mechanical	21.48%	4.82	4.54	5.01	4.88
Banks/ Insurance	20.74%	4.76	4.51	5.47	4.64
Logistics	15.56%	4.02	3.61	4.88	4.13
Public administration	14.07%	4.51	4.17	5.13	4.45
Electronics/ IT	12.59%	5.02	4.40	4.78	5.01
Pharma/ Chemical	11.85%	4.60	4.45	4.92	4.77
Others	3.70%	4.93	4.70	5.27	5.40

Revenue		Portfolio budget		Employees	
< 100 Mio EUR	20.74%	<10 Mio EUR	19.26%	<500	28.89%
100-500 Mio EUR	21.48%	10-30 Mio EUR	22.96%	500-2000	28.15%
501-2,000 Mio EUR	25.92%	30-100 Mio EUR	22.96%	>2000	42.96%
> 2,000 Mio EUR	31.85%	>100 Mio EUR	34.81%		

For measuring dynamic capabilities and portfolio agility, we use Likert scales from 1 ("strongly disagree") to 7 ("strongly agree").

3.4.2 Measurement

Informants assessed the constructs using multi-item measurement scales. We derived the scales from previous literature except for the construct of dynamic capabilities, which we derived from Teece (2007) and adapted to the PPM context. Some items were adjusted to fit the context better. The corresponding literature source can be found in the introduction of the respective variable. Unless otherwise stated, informants rated the items on a seven-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). We applied measures to reduce a possible common method bias (Podsakoff et al., 2003; Chang et al., 2010). First, we used different informants for the independent and dependent variables. Second, we also assessed other variables besides those used in this study. Therefore, participants could not recognize the relationship between the respective variables or infer our specific research objectives from the questionnaire. Further, we formulated the questions objectively (e.g., “Essential project decisions are made within clearly defined portfolio meetings.”), which supported the psychological and proximal separation of the questions.

To assess validity, we applied a principal component factor analysis followed by a confirmatory factor analysis (CFA) (Podsakoff et al., 2003). The CFA had a good fit ($\chi^2[df = 676] = 960.87$; $RMSEA =$

0.056; $SRMR = 0.070$; $CFI = 0.913$). Furthermore, we used Cronbach's Alpha with a cut-off value of 0.7, the average variance extracted, and composite reliability for scale reliability (Ahire and Devaraj, 2001). We list all item wordings and the CFA results in Table 7.

Table 7. Survey Items (Research study B)

Construct	Items	Loading
Dynamic Capabilities	2nd order construct (Alpha = .731; AVE = .519; CR = .752), portfolio coordinator informant	
Sensing	(Alpha = .852; AVE = .639; CR = .843)	.47
	We are good at identifying opportunities for new projects.	.75
	We frequently scan the environment for new project ideas.	.81
	We quickly identify changes in our environment that might affect the project portfolio.	.84
Seizing	(Alpha = .816; AVE = .555; CR = .822)	.71
	We often prioritize projects in new topic areas …	
	... that have a large economic potential.	.87
	... in which we expect fast progress in reaching their potential.	.85
	... in which we suffer competitive disadvantages if we entered too late.	.74
	When an innovation (technology, business model, process innovation) within our portfolio shows great potential, we are quickly able to exploit this innovation on a larger scale.	.42
Reconfiguring	(Alpha = .865; AVE = .707; CR = .881)	.91
	We continuously attempt to improve our portfolio management processes to enhance our competitive position.	.83
	We are able to reconfigure our portfolio management processes to react to the changing business environment.	.88
	We adapt decision-making processes within portfolio management if the environment changes.	.82
Portfolio Agility	(Alpha = .806; AVE = .502; CR = .801), decision maker informant	
	We quickly adapt our project portfolio to ...	
	... changing customer needs and competitive conditions.	.71
	... changing resource situations.	.65
	... new technologies.	.72
	... changing strategic goals.	.75

Construct	Items	Loading
Technology turbulences	(Alpha = .832; AVE = .646; CR = .842), decision maker informant	
	The technology in our industry is changing rapidly.	.83
	There are frequent technological breakthroughs in our industry.	.93
	Technological changes provide big opportunities in our industry.	.62
Formalization PPM	(Alpha = .928; AVE = .757; CR = .925), portfolio coordinator informant	
	Essential project decisions are made within clearly defined portfolio meetings.	.79
	Our project portfolio management process is divided in clearly defined phases.	.81
	Our process for project portfolio management is clearly specified.	.92
	Overall, we execute our project portfolio management process in a well-structured manner.	.95
Portfolio success	2nd order construct (Alpha = .814; AVE = .522; CR = .844), decision maker informant	
Future preparedness	(Alpha = .884; AVE = .656; CR = .864)	.68
	We develop new technologies and/ or competencies in our projects to succeed in the future.	.81
	Our projects for new products, technologies, or services take us a step ahead of our competition.	.86
	The projects enable us to shape the future of our industry.	.89
Average product success	(Alpha = .860; AVE = .567; CR = .881)	.61
	Our products/ project results achieve the target costs defined in the project.	.62
	Our products/ project results of the project achieve the planned market goals (e.g., market share).	.69
	Our products/ project results achieve the planned profitability goals (e.g., ROI).	.95
	Our products/ project results achieve the planned payback period.	.93

Construct	Items	Loading
Strategic implementation success	(Alpha = .854; AVE = .617; CR = .863)	.83
	The project portfolio is consistently aligned with the future of the company.	.87
	The corporate strategy is ideally implemented through our project portfolio.	.90
	Our project resource allocation reflects our strategic objectives.	.70
	The implementation of the strategy is considered a great success in the organisation.	.64
Synergies	(Alpha = .753; AVE = .532; CR = .770)	.67
	During project execution, development synergies (e.g., shared use of modules, platforms, technologies, etc.) between projects are realized.	.83
	After project completion, exploitation synergies (e.g., shared marketing/ sales channels, infrastructure, etc.) between projects are realized.	.74
	We hardly ever have double work or redundant development.	.60
Portfolio balance	(Alpha = .885; AVE = .667; CR = .888)	.80
	There is a good balance in our project portfolio ...	
	... between new and existing areas of application.	.87
	... between new and existing technologies.	.85
	... between projects that develop new competences and projects that utilize existing competences.	.79
	... between risk and returns.	.75

$\chi^2[df = 676] = 960.87$; $RMSEA = 0.056$; $SRMR = 0.070$; $CFI = 0.913$

Dependent variable. Portfolio success is operationalized as a five-dimensional second-order construct which includes future preparedness (3 items), average product success (4 items), strategic implementation success (4 items), synergies (3 items), and portfolio balance (4 items). The construct is taken from existing literature (Jonas et al., 2013; Kock et al., 2015; Kaufmann et al., 2021). Senior management decision-makers assessed the construct.

Mediator. Portfolio agility is measured as a four-item construct taken from prior literature (Kock and Gemünden, 2016). The construct describes the extent to which a firm can adapt quickly to changing circumstances within the portfolio. Senior management decision-makers assessed the construct.

Independent variables. For dynamic capabilities, we used three variables corresponding to sensing, seizing, and reconfiguring dimensions from Teece (2007). As this is the first quantitative study to directly operationalize dynamic capabilities in PPM, we adapted these constructs to the PPM context and explicitly referred to projects and portfolio management, following Petit (2012). The sensing variable consists of three items and refers to the ability to identify opportunities for new projects within the portfolio, considering the portfolio's environment and possible changes in it. Our understanding is similar to Petit (2012, p. 542), who describes sensing as "structures, tools, and processes to sense, filter, and interpret changes and uncertainties" in PPM. We illustrate the seizing dimension with four items that reflect the selection of projects to exploit the optimal potential in the portfolio. Petit (2012, p. 547) stated that the business model is an important component of the seizing mechanism because it is "used as the decision criteria to select, prioritize, and group components into projects". Therefore, we asked project portfolio coordinators if they explicitly exploit innovations like, for example, business models or processes if they show potential. Lastly, the reconfiguring dimension comprises three items that refer to the ability to reconfigure and continuously improve the PPM processes (Petit, 2012). Portfolio coordinators assessed the three variables.

Control variables. We controlled for several variables that might affect portfolio agility and portfolio success. The *firm size* indicates the number of firm employees (natural logarithm) (Kopmann et al., 2017; Kaufmann et al., 2021). Furthermore, we included the portfolio budget with the natural logarithm of the portfolio's annual budget in million euros. We added the share of projects with really new content (*share newness*) in percentage. To control the portfolio's environment, we added *technological turbulences* with three items (Kock et al., 2015) since dynamic capabilities depend on environmental dynamism (Schilke, 2014). Finally, we also controlled for the degree of *formalization* of the PPM process by measuring a four-item construct (Teller et al., 2012; Schultz et al., 2013). We present the constructs' descriptives and correlations in Table 8.

Table 8. Descriptives and correlations (Research Study B)

Variables	M	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Portfolio success	4.57	0.80	1.0								
(2) Portfolio agility	4.67	1.06	.51	1.0							
(3) Sensing	4.64	1.29	.17	.25	1.0						
(4) Seizing	4.32	1.14	.17	.23	.58	1.0					
(5) Reconfiguring	5.07	1.43	.12	.22	.30	.54	1.0				
(6) Firm size (ln)	7.34	1.98	-.06	-.09	.16	.15	.03	1.0			
(7) Portfolio budget (ln)	3.65	1.67	.03	-.03	.12	.09	.16	.43	1.0		
(8) Share newness	20.98	21.13	-.10	.04	.10	.10	-.04	-.05	-.27	1.0	
(9) Technology turbulence	4.94	1.32	.23	.18	.12	.08	.11	-.14	.04	.01	1.0
(10) Formalization PPM	4.98	1.66	.16	.15	.16	.42	.66	.16	.13	-.05	.06

n = 135; M = mean; SD = standard deviation; all correlations above .16 are significant at the 5%-level.

3.5 Results

We test the hypotheses in two ways. In the first step, for hypotheses H1 and H2a, we use structural equation modeling (SEM) in Stata 16 to test whether dynamic capabilities as a second-order construct positively relate to portfolio agility, which then mediates the relationship between dynamic capabilities and portfolio success. The overall model with control variables provided a good fit ($\chi^2[df = 349] = 512.76$; $RMSEA = 0.059$; $SRMR = 0.077$; $CFI = 0.915$). Figure 4 summarizes the SEM results. The three dimensions of dynamic capabilities sensing (λ=.470; p=.000), seizing (λ=0.707; p=.000), and reconfiguring (λ=0.914; p=.000) loaded strongly on dynamic capabilities. This finding supports the second-order nature of the construct. Furthermore, dynamic capabilities related positively to portfolio agility (b=0.407; p=.033), confirming H2a. In addition, the model supports H1 in that portfolio agility benefits portfolio success (b=0.672; p=.000). To identify the indirect effect of dynamic capabilities on portfolio success through portfolio agility, we bootstrapped the results with 5,000 repetitions. This indirect effect of dynamic capabilities through portfolio agility on portfolio success is also significant (b=0.108; p=.015), thus confirming the mediating effect of portfolio agility on the relationship between dynamic capabilities and portfolio success. The direct relationship between dynamic capabilities on portfolio success is not significant, suggesting full mediation.

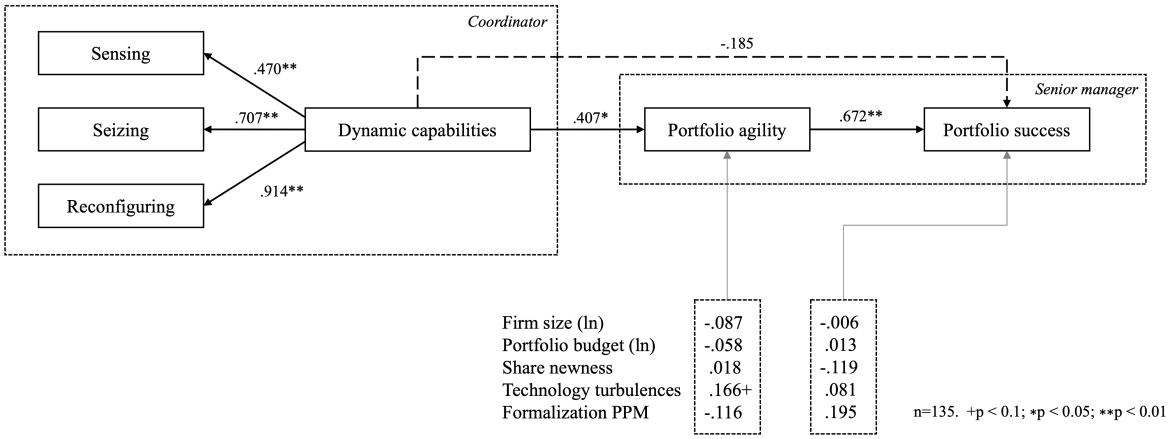

Figure 4. Results of structural equation model. Second-order modeling (Research Study B)

In a second step, we investigate the relationships between dynamic capabilities' individual dimensions and portfolio agility (H2b). We hypothesized that the three underlying dimensions of dynamic capabilities must occur simultaneously to unfold their full potential. Therefore, we used hierarchical ordinary least squares (OLS) regression with interaction effects to test our hypothesis. The analysis and results are shown in Table 9. Model 1 includes the control variables and tests their relationship with the mediator variable portfolio agility. Technology turbulence (b=0.127; p=.069) and PPM formalization (b=0.097; p=.081) positively relate to portfolio agility, whereas the other control variables are not significant. In model 2, we included the three dimensions of dynamic capabilities. Sensing is positively significant (b=0.148; p=.088), while seizing and reconfiguring remain insignificant (seizing: b=0.068; p=.534; reconfiguring: b=0.064; p=.487). Because the variables are highly correlated, the coefficient estimates in Model 2 cannot replicate the independent variables' effects on agility but show the variables' partial effects.

However, the three-way interaction term has a significant relationship with portfolio agility (b=-0.069; p=.036), partly confirming H2b. While there is a relationship between the dimensions, the interaction term does not indicate the dimensions to be entirely complementary. To better understand this result, we plotted the simple slopes in Figure 5. The dimension seizing is plotted on the x-axis. The graph shows the relationship between seizing and portfolio agility depending on the other two dimensions of sensing and reconfiguring[1]. If sensing and reconfiguring are both low, there is a negative relationship between seizing and portfolio agility, and the absolute value of portfolio agility is at its lowest along the seizing dimension. However, if one of the two dimensions is highly pronounced, the relationship between seizing and portfolio agility becomes positive. Therefore, apart from seizing, at least one of the dimensions of sensing or reconfiguring is needed. On the other hand, if seizing is low, the overall

[1] High (low) values describe the mean value plus (minus) one standard deviation.

portfolio agility is at its highest if the sensing capability is high, regardless of reconfiguring. This effect then diminishes with increasing seizing capability. Consequently, sensing might play a more important role in PPM than reconfiguring. Model 2 supports this interpretation because the sensing coefficient is solely significant. The findings will be discussed in the next section.

Table 9. Regression results (Research study B)

	Portfolio agility			Portfolio success	
	(1)	(2)	(3)	(4)	(5)
Firm size (ln)	-0.05 [0.35]	-0.06 [0.26]	-0.07 [0.19]	-0.02 [0.59]	-0.01 [0.73]
Portfolio budget (ln)	-0.00 [0.95]	-0.02 [0.73]	-0.05 [0.41]	0.01 [0.82]	0.02 [0.71]
Share newness	0.00 [0.64]	0.00 [0.95]	-0.00 [0.85]	-0.00 [0.11]	-0.00 [0.14]
Technology turbulence	0.13+ [0.07]	0.10 [0.14]	0.12+ [0.09]	0.08+ [0.09]	0.07 [0.12]
Formalization PPM	0.10+ [0.08]	0.03 [0.71]	0.05 [0.48]	0.07 [0.17]	0.05 [0.28]
Sensing		0.15+ [0.09]	-0.87 [0.15]	0.03 [0.66]	0.33 [0.44]
Seizing		0.07 [0.53]	-1.96** [0.01]	0.04 [0.56]	0.87+ [0.10]
Reconfiguring		0.06 [0.49]	-1.10* [0.04]	-0.08 [0.21]	0.30 [0.43]
Sensing x seizing			0.38* [0.03]		-0.16 [0.18]
Sensing x reconfiguring			0.20 [0.12]		-0.06 [0.48]
Seizing x reconfiguring			0.39* [0.01]		-0.16 [0.13]
Sensing x seizing x reconfiguring			-0.07* [0.04]		0.03 [0.18]
Portfolio agility				0.36** [0.00]	0.38** [0.00]
Constant	3.89** [0.00]	3.23** [0.00]	8.81** [0.00]	2.43** [0.00]	0.63 [0.70]
R-squared	0.062	0.122	0.183	0.314	0.330
Adjusted R-squared	0.025	0.066	0.102	0.265	0.258

OLS regression; n (project portfolios) = 135; unstandardized regression coefficients are reported; + > 0.1; ∗p < 0.05; ∗ ∗p < 0.01; p-value in brackets

Models 4 and 5 show the relationship between the independent variables, the mediator portfolio agility, and the dependent variable portfolio success. The three-way interaction term is not significant for portfolio success (b=0.03; p=.184). Though, portfolio agility has a positive relationship with portfolio success, supporting H1 (Model 4: b = 0.363; p = 0.000; Model 5: b = 0.384; p = 0.000). We can say the regression, besides testing H2b, confirms our findings from the SEM that agility mediates the relationship between dynamic capabilities and portfolio success and that there is a strong relationship between agility and portfolio success.

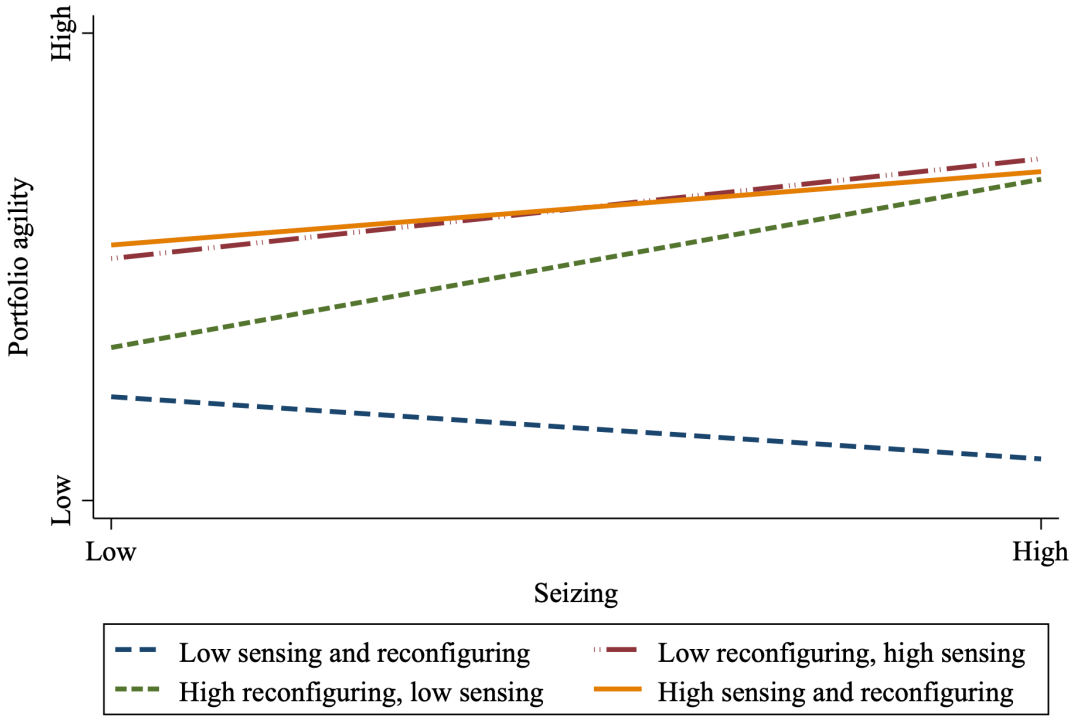

Figure 5. Simple slopes (Research Study B)

3.6 Discussion

Dynamic capabilities enable firms to gain competitive advantages by adapting quickly to changing environments and "shape them through innovation" (Rothaermel and Hess, 2007; Teece, 2007, p. 1319). The dynamic capabilities framework suggests three dimensions representing dynamic capabilities on the firm level: *sensing* market and technology opportunities, *seizing* opportunities through prioritizing and exploiting innovations, and continuously *reconfiguring* assets and structures (Teece, 2007; Helfat and Peteraf, 2015). This study aimed to empirically investigate the relationship between dynamic capabilities and portfolio agility, the complementarity of dynamic capabilities, and the mediated effect of portfolio agility between dynamic capabilities and portfolio success.

First, the results from the SEM (Figure 4) confirm the positive relationship between portfolio agility and portfolio success in PPM (Kester et al., 2014). Portfolio agility enables firms to quickly and flexibly adapt to changing environmental conditions (Sambamurthy et al., 2003; Roberts and Grover, 2014). Therefore, the portfolio can quickly change its composition to achieve a better balance. It further allows portfolios to align the portfolio with the strategy continuously. Kester et al. (2011) state that a quick shift towards more promising projects by terminating others can improve the value of the overall product success. This also contributes to the synergies of a portfolio as a faster shift of resources avoids duplication of work.

Second, we argued that the complementarity of the three dimensions of sensing, seizing, and reconfiguring positively relates to portfolio agility. Here, we tested two alternative hypotheses: the relationship between portfolio agility and dynamic capabilities, where dynamic capabilities are conceptualized as a second-order construct, and the effect of dynamic capabilities as a three-way interaction on portfolio agility. No alternative prevails in the study, but both alternatives let us explore different perspectives of dynamic capabilities.

For the first alternative, our study showed that portfolio agility mediates the relationship between the dimensions from Teece (2007) and portfolio success. As Schilke et al. (2018) point out, the intermediate outcome of dynamic capabilities is changing the resource base, leading to higher performance. In a project portfolio, the dimensions of sensing, seizing, and reconfiguring, reflecting parts of the PPM process, contribute in the first step to portfolio agility and then to portfolio success. We open the black box and argue that dynamic capabilities implicitly relate to portfolio success, mainly driven by portfolio agility. Dynamic capabilities enable portfolios to become flexible and balance exploring new opportunities and relying on the current business (Davies and Brady, 2016).

However, for our second alternative, we found a more complex three-way interaction in our regressions (Figure 5). If project portfolio management lacks both capabilities of sensing and reconfiguring, project portfolio managers cannot sense changes in the environment or seek new possible project ideas. Furthermore, adapting their portfolio processes seems equally difficult for those firms. It possibly leads to less advanced seizing capability and, conclusively, to overall low portfolio agility. Decision-makers and portfolio managers are unable to "back the right horse" and exploit the best opportunity. Likewise, poor decision-making makes the portfolio slow to adapt (Kock and Gemünden, 2016).

If the company is good at at least one capability of seizing or reconfiguring, the situation changes, and the portfolio becomes more agile. First, solid sensing of opportunities could give organizations a time advantage. Decision-makers would then be able to decide on suitable projects earlier. This might be especially relevant for organizations with a dedicated project portfolio which is highly common in certain industries. In summary, for some industries, investing more into the sensing capability within the portfolio would be more beneficial by building up R&D resources, for example.

Further, if reconfiguring is highly pronounced, the organization can adapt its PPM processes. An exemplary case of reconfiguring would be increasing the portfolio review frequency from quarterly to monthly reviews. In combination with a good seizing capability, firms still increase their portfolio agility because they can easily change their processes to use emerging opportunities better. Nevertheless, if organizations are low at sensing and reconfiguring and are at the point of deciding where to build their capabilities, our results might give some orientation. As shown in the results, the sensing capacity is dominant. Therefore, sensing should not be neglected and maybe chosen first, as spotting business opportunities is an essential capability for portfolio agility (Teece et al., 2016). In line with our study, Steen et al. (2021) found that sensing and seizing are interrelated in an open innovation context for interfirm projects. They specified sensing as external sourcing and revealing information for innovation and seizing as project network competencies and problem-solving abilities. They found that these categories influence a firm's innovation performance. In contrast, we generalized the findings for all types of project portfolios, which is why our conceptualization of Teece's dimensions is more generally applicable. Further, we integrated reconfiguring, arguing that questioning PPM processes is valuable for becoming agile.

3.7 Conclusions

3.7.1 Theoretical Implications

This paper yields several contributions to dynamic capabilities and project portfolio management research streams. First, the paper adds interesting insights to the literature on dynamic capabilities in PPM (Killen et al., 2012; Petit, 2012; Davies and Brady, 2016; Teece et al., 2016). By empirically demonstrating that the dimensions from Teece (2007) contribute to portfolio agility and portfolio success, we offer a theoretical perspective on how the three dimensions of sensing, seizing, and reconfiguring can be interpreted in PPM. To our understanding, the dimensions are characteristics of the PPM process. This study's findings thus broaden the view of Killen and Hunt (2010). While they explained portfolio management as a dynamic capability with the "processes, positions, paths" framework from Teece et al. (1997), we add insights to the processes by integrating the elaborated dimensions of Teece (2007) as proposed by Petit (2012). The three-way interaction of the dimensions enabled us to identify the importance of each dimension. Additionally, with the mediated model, we show that portfolio agility is one of the mechanisms that lead to performance variations, as it represents changes within the resource base. Therefore, this study indicates that portfolio agility mediates dynamic capabilities, which answers the call for further research on dynamic capabilities' mechanisms and intermediate outcomes (Killen et al., 2012; Schilke et al., 2018).

Second, the findings shed light on the research field on agility in PPM (Kester et al., 2014; Kock and Gemünden, 2016; Hoffmann et al., 2020; Kaufmann et al., 2020). The results broaden the view on antecedents of portfolio agility under consideration of dynamic capabilities. As Kock and Gemünden (2016) point out, the research field of antecedents of agility in PPM is scarce. Their study identified structural components of a project portfolio, which serve as antecedents for decision-making and, eventually, portfolio agility. With our research, we added processual components as antecedents to portfolio agility. Furthermore, their paper argued that decision-making in PPM is comparable to the "seizing" lens of dimensions. We could empirically confirm this assumption and expand the framework by integrating sensing and reconfiguring.

Lastly, we find that project portfolios must be aware of their environment and consider their context in project portfolio decision-making (Killen et al., 2012; Martinsuo and Geraldi, 2020). Here, dynamic capabilities support portfolios to identify and exploit internal and external potential. Ultimately, dynamic capabilities allow portfolios to be flexible while staying efficient because they can perceive the environment more realistically (Hoffmann et al., 2020). We demonstrated that dynamic capabilities positively associate with a portfolio's agility. Portfolios with high sensing, seizing, and reconfiguring better adapt to changing environments or resource situations.

3.7.2 Managerial Implications

The study demonstrates the relevance of portfolio agility and the aspiration for dynamic capabilities in PPM. We find a positive relationship between dynamic capabilities, portfolio agility, and portfolio success. Therefore, we encourage project portfolio managers and decision makers to integrate dynamic processes into their PPM and to challenge the current capabilities regularly, as this can bring a competitive advantage due to a more flexible and adaptive portfolio. Sensing means identifying upcoming trends, forcing portfolios to actively fill the project idea pipeline. This goes beyond just reviewing project proposals, looking for opportunities and maintaining an active idea portfolio management (Kock et al., 2015). Exemplary techniques and methods that support sensing might be roadmapping and foresight tools (Bengtsson and Lindkvist, 2017; Kock and Gemünden, 2019) or open innovation approaches to expand the knowledge breadth by getting in touch with external partners (Melo et al., 2021; Steen et al., 2021).

Seizing exploits projects opportunities that seem promising. Steen et al. (2021) recommend that seizing reflects a good project competence network where the project partners have good relationships and communicate well with each other in the case of open innovation. Other scholars emphasize good prioritization criteria to select suitable projects (Daniel et al., 2014). We think being good at seizing PPM requires a certain maturity of PPM basics, such as good communication and formalization (Teller et al., 2012). But this can also be reflected in other factors. Future research may examine the prerequisites of seizing to identify the most important factors.

Reconfiguring describes questioning current PPM practices and adjusting them if necessary. Practitioner frameworks such as scaled agile portfolio management (SAFe) support "relentless improvement" and have anchored this learning culture as a core value (Leffingwell, 2007). Of course, portfolios do not have to convert directly to agile, but portfolio managers can use the core values as a guide and inspiration. This means, for example, having regular meetings to review the PPM process, collecting feedback from portfolio stakeholders, and evaluating if the trends that came up through a good sensing capability not only initiate new projects but also change PPM routines and processes. Due to changes in the environment and upcoming trends, project portfolios must continuously adapt their prioritization and success criteria for projects, as the case of sustainability demonstrates (Sabini et al., 2019). Here, requirements of sustainability conflict with traditional competitive requirements forcing companies to adapt their processes (Hengst et al., 2020). Thus, reconfiguring is an essential antecedent for a portfolio's agility.

Lastly, the results show an interaction term between the three dynamic capabilities constituting portfolio agility. Thus, we recommend that decision-makers prioritize, especially if resources are scarce, which capability to build first. Even if sensing has the greatest impact on portfolio agility, investing in other capabilities first for different kinds of project portfolios or industries could make sense.

3.7.3 Limitations and Future Research

Several limitations should be considered while interpreting this study's results. First, we used a cross-sectional study to test our hypotheses. Therefore, we cannot entail causality from correlational evidence between variables. Even though we used different informants for the independent and dependent variables, we cannot entirely exclude the possibility of common method bias (Podsakoff et al., 2003). Future research could perform a longitudinal or action research design to investigate how building up dynamic capabilities over time impact a portfolio's agility.

Second, we operationalized dynamic capabilities to reflect the PPM process and thus cannot investigate underlying practices that shape dynamic capabilities. Here, micro-foundations that move beyond the project portfolio level might significantly influence building dynamic capabilities. Future research could explore individuals who shape dynamic capabilities, such as project managers acquiring specific skills or experience. Additionally, another area of research interest might involve comparing different types of leadership among senior management, which either support or hinder the utilization of dynamic capabilities in PPM.

Third, we offer relevant insights into the interplay among the three dynamic capability dimensions. Yet, contingency factors (e.g., the industry sector or portfolio characteristics such as size or type) may also influence the relationship between dynamic capabilities and portfolio agility. Especially in traditionally oriented types of project portfolios, like construction portfolios, other dimensions of the dynamic

capabilities might become more critical due to the less volatile and more predictable environment. Future research could compare different industries or other factors to determine when and which skills become important.

Nonetheless, dynamic capabilities change over time, and companies must learn new dynamic capabilities regularly (Teece et al., 1997; Helfat et al., 2009; Söderlund, 2011). This might open avenues for future research. For example, Schilke et al. (2018) point out that building dynamic capabilities and strategic change is a process that does not occur directly. Therefore, it could be interesting to examine the process of building capabilities. In this regard, a longitudinal research approach to project portfolios could give more conclusions about the change in dynamic capabilities.

Chapter 4 Research Study C:

The Relevance of Urban Agglomeration Micro-Foundations for the Emergence of Innovation in Living Labs: A Qualitative Field Study

Abstract:

Living labs are one method to integrate sustainability measures among urban actors and to increase innovation activities in an area. Research found evidence that innovation drivers in these projects are based on agglomeration effects, meaning that innovation activities aggregate because of urban initiatives. However, agglomeration effects are not equally distributed and are always beneficial among actors. Therefore, this paper investigates which underlying agglomeration mechanisms lead to trade-offs between living lab actors and how they develop over time. We conduct a two-year ethnographic field study from the application phase of an urban living lab with multiple subproject innovation initiatives until the first year of its implementation. We collected data through field observations (e.g., project meetings), documentary data from the application sketch to the elaborated project plan, and interviews with 34 different internal and external project stakeholders (i.e., sub-project leaders on the university and industry side). The findings suggest that agglomeration effects do not occur consistently but depend on the respective partner, type of micro-foundation, or time in the project. The study underscores the importance of urban agglomeration effects on living labs and contributes to the literature on urban innovation and a more differentiated view of their agglomeration micro-foundations.

Classification in terms of this dissertation:

- **Tensions:** Local trade-offs
- **Sample:** 34 interviews and additional data
- **Method:** Two-year ethnographic field study with

Publication:

Bechtel, Jadena; Kock, Alexander (2023): The Relevance of Urban Agglomeration Micro-Foundations for the Emergence of Innovation in Living Labs: A Qualitative Field Study. In: *Journal of Cleaner Production*. DOI: 10.1016/j.jclepro.2023.139280

An earlier version was presented at the International Product Development Management Conference 2022, Hamburg, Germany.

4.1 Introduction

Due to the sustainability transition, which is a "fundamental transformation towards more sustainable modes of production and consumption" (Markard et al., 2012, p. 955), governments have invested heavily in recent years in innovation projects, creating financial incentives for companies to participate (Lindberg et al., 2019; Krieger and Zipperer, 2022). Companies feel pressure to align their strategies sustainably to remain competitive and innovative (Hengst et al., 2020; Klein et al., 2021). For example, with the Energy Research Program "Innovations for the Energy Transition," the German government sets out guidelines for energy research funding in the coming years, supporting projects with around 6 billion euros (Federal Ministry for Economic Affairs and Energy, 2021). One program focus is establishing living labs that test technologies at an operational level and identify innovation potential. The term 'living labs' subsumes several forms of open innovation in which different actors collaborate on a local level to innovate on a common topic, for example, the energy transition (Voytenko et al., 2016; Coffay et al., 2022; Fuglsang and Hansen, 2022). Living labs often focus on urban areas because cities consume many resources and offer the potential for development through established industry and research (Kroh, 2021).

Two aspects of such urban living labs have received little attention so far, which might harm the labs' innovation success. First, even though the literature on living labs emphasizes collaboration on an urban level, it might not be advantageous for every collaborating partner. One reason for trade-offs between local actors is agglomeration effects, which describe the impact of geographic concentration (e.g., of a specific industry) on firms and the local area (Marshall, 1890; Duranton and Puga, 2004). Research has shown that agglomeration can explain why innovative firms settle in a region, which leads to a more innovative or financially better output for these resident firms (Carlino and Kerr, 2015). However, agglomeration effects are not always equally distributed, and some regional actors or industries may benefit more than others (Mathias et al., 2020). Research has not yet investigated those effects and their impact on a living lab's development, although agglomeration could be a primary driver or barrier to the successful growth of a living lab (Nevens et al., 2013; McCrory et al., 2020).

Second, most research investigates living labs that have already started (Fuglsang and Hansen, 2022). As many living labs are publicly funded, the start of living labs marks the success of the application phase. Thus, research potentially ignores the profound uncertainty and risk during the planning phase. For example, stakeholders invest time in finalizing project proposals, although the final project acceptance is uncertain. A longitudinal perspective of living labs could shed light on the emergence of living labs and the participation of different stakeholders in living labs over time (Hossain et al., 2019). In addition, it makes sense to investigate agglomeration effects before launching a living lab because partners typically meet in the project application phase.

Addressing these research gaps, we ask: *Which underlying agglomeration mechanisms lead to trade-offs between different living lab actors, and how do they develop over time?*

To answer the research question, we rely on the micro-foundations of agglomeration as a research framework that distinguishes three underlying mechanisms: sharing, matching, and learning (Duranton and Puga, 2004). We conduct a two-year ethnographic case study from the application phase of an urban living lab with multiple subproject innovation initiatives to the first year of its implementation after the application approval. We collect data through field observations (e.g., project meetings), documentary data from the application sketch to the elaborated project plan, and interviews with 34 project stakeholders (i.e., sub-project leaders on university and industry sides). To analyze our results, we rely on the analytical approach by Goffin et al. (2019).

Our findings suggest that not all agglomeration effects promote project work in a living lab. Further, it depends on the actor and our investigation's time. Whereas university actors could draw advantages from the locality, companies had uncertainties, especially in the project application phase, due to the agglomeration. After the project started, they were deprived of some advantages even later. However, the urban work across partners opened up new possibilities for developing methods and finding solutions for the energy transition due to agglomeration effects.

With our study, we make several contributions to theory and practice. The study is the first to transfer agglomeration theory to living labs. We thus contribute to the literature on living labs and their role in the urban sustainability transition (Nevens et al., 2013; Hossain et al., 2019; Fuglsang and Hansen, 2022). Further, we extend the research of agglomeration effects by a qualitative investigation that enabled a longitudinal consideration of agglomeration effects (Duranton and Puga, 2004; Mathias et al., 2020). We demonstrated that micro-foundations have different effects on the different types of local actors. Lastly, we derive managerial recommendations for companies, universities, policymakers, and living lab organizers.

4.2 Theoretical Background

4.2.1 Living Labs

Living labs—a recently emerging phenomenon—are platforms for innovations, benefiting private companies and public organizations while placing citizens and their needs at the center (Gascó, 2017; Fuglsang and Hansen, 2022). The term lab is combined with other words besides ‘living,’ for example, real-world, urban living, learning, change, or transformation lab (McCrory et al., 2020). However, the terms have a similar meaning, i.e., governments and authorities create incentives for cities to experiment in a real-life setting with new ideas, leading to innovative solutions (Kronsell and Mukhtar-Landgren,

2018; Compagnucci et al., 2021). We will use the term living lab in the following to remain consistent. Living labs are a unique form of (open) innovation ecosystems focused on co-creation and co-production (Pallot, 2009; Nevens et al., 2013; Kroh, 2021; Leminen et al., 2021). Although living labs are fundamentally similar in their objective, they encounter diverse topics, involved stakeholders, and types of partnerships, making research on living labs complex. In an urban environment, living labs "address a range of challenges including new technology, climate, building retrofit, food production, urban landscape, sustainability, low carbon economy, with goals that vary between post-carbon living, technology change, knowledge production, and economic growth" (Voytenko et al., 2016, p. 47).

Living Labs often have a sustainable background to drive the sustainability transition in cities (Voytenko et al., 2016; David and Gross, 2019; Leminen et al., 2021). Nevens et al. (2013) give several reasons for this topic choice: firstly, cities are primary actors in unsustainable behavior, as most consumption and production take place there; accordingly, the city is a good starting point for implementing sustainability measures with political authorities. In their literature analysis, McCrory et al. (2020) identify three lab characteristics, which they describe concerning sustainability. First, living labs occur in a confined space, emphasizing an experiment's character (Weiland et al., 2017). Second, living labs apply different processes that support problem framing and the development of solutions. Third, the organization's dimension portrays stakeholders and resources involved in the living lab. Further, they describe that sustainable living labs touch different research streams of geography, innovation, sustainability, and governance.

Experimentation through living labs can facilitate institutional change by deinstitutionalizing existing configurations while institutionalizing more adequate ones (Fuenfschilling et al., 2018). This can be of utmost importance in the energy field, which needs multiple institutional and technical changes to conform to the already reshaped social-political ones (Verzijlbergh et al., 2017). The departure from the unsustainable forms of energy production to sustainable ones presents a type of exnovation process in which current technology needs to be replaced by a better-suited technology in line with new political goals (Dvarioniene et al., 2015; David and Gross, 2019). In conclusion, living labs are locally concentrated, therefore, agglomeration theory provides a valuable theoretical perspective.

4.2.2 Innovation and Micro-Foundations for Urban Agglomeration

Marshall (1890) described the fundamental concept of agglomeration effects or economies that geographic concentration happens if economic activities (e.g., industry) are similar. Agglomeration economies further enable access to resources like knowledge, human capital, or other needed input for firms (McCann and Folta, 2011), which bring better financial (Porter, 1998) or innovation performance. (Marshall, 1890) highlighted how agglomeration effects promote the diffusion of innovations and ideas.

In innovation literature, researchers use knowledge spillover effects due to agglomeration economies as the central premise of why the innovation activity of firms increases in regional clusters (Alcácer and Chung, 2007). But agglomeration economies and their effects on innovation depend on different aspects like the degree of innovation (incremental vs. radical) (Audretsch and Feldman, 2004; Hervas-Oliver et al., 2022), the type of industry (e.g., high-tech industry) (Mathias et al., 2020), and the type of urban actor.

In their meta-analysis, Mathias et al. (2020) investigated the effect of urban agglomeration on an individual firm's innovation and financial performance. They found that a firm's age moderates the relationship between agglomeration and innovative/ financial performance. While nascent firms benefit from agglomeration effects regarding their innovative performance, incumbents experience this relationship with economic outcomes. Further, it depends on the industry type and maturity. Start-ups are a particular case of nascent organizations. Capozza et al. (2018) found that start-ups benefit from diverse and industry-specific knowledge areas. Further, the settlement of innovative start-ups depends on the relatedness of industries located in the surrounding area (Gao et al., 2021).

Another factor that enables innovation activities through agglomeration is research institutes, such as universities (Orlando et al., 2019; Schlegel et al., 2021). Arguing that universities are located in cities and promoting cooperation with the local industry leads to knowledge spillovers and increases innovative performance in these geographical clusters (Cowan and Zinovyeva, 2013). In conclusion, different actors in a geographical cluster vary in success from agglomeration effects. It depends on the case under investigation (e.g., type of industry).

Duranton and Puga (2004) present three underlying mechanisms (micro-foundations) that explain the emergence of agglomeration effects (i.e., an increase in innovative activities in a regional cluster): (1) sharing (i.e., sharing local facilities and gains from attracting more labor), (2) matching (i.e., improving matching chances and quality between resources of an urban economy), and (3) learning (i.e., increased knowledge generation, diffusion, and accumulation within regional actors). In the following, we will describe the three micro-foundations in further detail regarding their advantages for geographic clusters and possible pitfalls.

Sharing includes sharing *resources*, *gains*, and *risks* due to a geographic cluster. First, sharing resources focuses on the infrastructure of a region (i.e., indivisible goods and facilities, customers) that is advantageous for economic actors. Further, companies benefit from a greater variety of specialized individuals. It implies that there must be a balance between a good choice of labor (or intermediate suppliers) and sufficient specialized expertise in a region. In addition, specialized personnel add up to a thematically clustered region. Thummadi and Paruchuri (2022) transferred the character of sharing in a broader sense to tacit knowledge of an area that helps actors apply the knowledge and draw advantages from it.

Matching explains how matching resources (e.g., a worker fits with a company) increases quality and chances and how those advantages mitigate possible hold-up problems. The basic process from Duranton and Puga (2004) regarding *quality* is that more agents strengthen competition, as labor increases disproportionately to companies. Further, more choices lead to a more suitable match for both sides and a higher *chance* of finding a match. In addition, workers are not necessarily tied to one company or vice versa, as a possible specialization into a thematic field (asset specificity) becomes less of a problem when further geographical opportunities for matching open up.

Learning describes that a conglomeration of people inevitably leads to learning opportunities through knowledge *generation, diffusion*, and *accumulation* (Duranton and Puga, 2004). Prior research stated that learning primarily supports innovations because knowledge spillovers occur more frequently in dense geographic areas (Carlino and Kerr, 2015). For nascent firms, a diversified region might be better at first to know different products and processes. Later, incumbents move into specialized areas, exchanging ideas with homogenous firms. Individuals who already have more excellent knowledge or skills drive knowledge diffusion. However, regional diffusion of information can moreover lead to disadvantages for firms. Duranton and Puga (2004) discuss the problems of inefficient herding (incorrect information from one company influences the other companies' decisions) and strategic delays (companies wait for others to make decisions before they act themselves). Lastly, knowledge accumulation means that stakeholders can benefit from regional innovations and expand their knowledge, as innovations might lead to spillover effects.

Duranton and Puga (2004) discuss micro-foundations of agglomeration in smart cities and their policies. They found that policies regarding smart cities (e.g., implementing smart information and communication technology) increased patent activities in that area, arguing that knowledge accumulation happens within cities, leading to knowledge spillovers in that region.

Consequently, local initiatives are generally conducive to innovation, but the agglomeration effects do not affect every actor equally at every point in time.

4.3 Method

4.3.1 Research Context

We studied agglomeration effects in a living lab in Germany. The living lab is part of the energy research program "Innovations for the Energy Transition" of the federal government, aiming to reach energy and climate policy goals. One focus of the program is implementing living labs for the energy transition. They strive for innovative solutions that can be introduced into a market on an industrial

scale. The living labs look at the systemic interplay of energy supply and demand at the level of, for example, a specific neighborhood, one or more selected cities, or even a span of several states.

The studied living lab aims to demonstrate that a technically proven potential for energy efficiency and flexibility is economically feasible and socially acceptable. For this purpose, the living lab needs to develop innovative solutions to bring successful technical pilots into widespread use by intelligently linking individual neighborhoods of the urban energy system under consideration of sector coupling.

The German Federal Ministry of Economics and Technology supports the studied living lab with around 40 million EUR, whereas the project volume is approximately 110 million EUR. The main objective is to save permanently about 14,500 tons of CO2 per year and increase electrical flexibility potential by around 4.5 MW. These savings and flexibility opportunities should continue to grow long after the project ends. The project involves industry, urban economy, and research/academia players. Further, start-ups are among the project participants. The thematic fields of the actors are very heterogeneous and represent important sectors that belong to urban development, such as the construction sector, the energy supply sector, and manufacturing industrial companies. Overall, the project has over 15 partners (i.e., firms and universities) and 45 persons working actively on the project. The living lab has ten subprojects, each handling a specific topic that ultimately contributes to the overall goal of energy efficiency and CO2 savings. The city where the living lab takes place is a typical medium-sized city structured into smaller neighborhoods (quarters) and located in a high-performance metropolitan region. Many universities and research institutions in the city already cope with energy efficiency and flexibility issues. In conclusion, the present situation gives the prerequisites for developing innovations through possible agglomeration effects.

4.3.2 Research Design and Data Collection

Research design

We conducted a longitudinal qualitative case study with triangulated data from 2020 to 2022. The authors had unfettered access to the project data and the project members. The authors participated in all important meetings during an initial round of interviews after six months of the project's start. Additionally, the authors were given access to all documents, including the initial project proposal, interim reports for the Federal Ministry, and the financial plans of the project.

Interviews

We conducted semi-structured interviews with 34 informants who were all part of the project consortium. The interviewees were, for example, subproject managers or part of the overall project coordination. In addition, the authors tried to interview at least one person from the scientific environment (e.g., university) and one from the industrial environment (e.g., municipal construction company) for each subproject. We did this to receive a comprehensive view of the working situation

within a subproject, as work behavior might differ between industry and scientific environments, and to mitigate information bias. The interviews lasted between 20 and 69 minutes (an average of 40 minutes). All interviews via video conference or telephone[2] were audio-recorded and then transcribed. In addition to the formal interviews, the authors were in lively exchanges with the project participants to document new information or developments in the subproject as part of the field observation. To grant anonymity to the participants, we assigned random numbers to the interviews (e.g., N2, N30). In Table 10, we give an overview of the interviewees, their job titles, and the length of the interviews.

Field observation

The authors had access to and received invitations to all critical meetings since early 2020, over a year before the project started. Therefore, we could accompany the project proposal process until the project begins to recognize significant changes or challenges (e.g., in the planned measures) that might not be visible after the ministry approves its plans. This included formal meetings and informal phone calls or lunch breaks with the project coordination team that worked on the proposal. After the project started, the authors participated in every formal regular project meeting (see Table 11 for further details). The field observation opened the possibility of gaining an in-depth understanding of the project development. Further, the authors learned more about the motivation behind the project participation of the different actors. In the following, we state observations with the abbreviation "(obs.)" if we refer to an informal field note.

Documentary data

The authors had access to all data regarding the project organization. The documents contain minutes of regular meetings (once a month)/ milestone meetings (every three months)/ general project meetings (half a year with representatives from the project-executing agency and the Federal Ministry), the initial project sketch, project proposal, project plan (time and budget plans), success control, project presentations, interim reports, and cooperation agreements. Through the documentary data, the authors could objectively track the project's development and the insight from the field observation. In the following, we note text parts in the results with "(doc.)" if we refer to those sources. We give an overview of the sample structure in Table 11. All documents enabled us to validate our data from the interviews.

[2] We could not meet the interviewees in person due to the coronavirus pandemic and the associated restrictions in Germany in 2021.

Table 10. Interviewee background information (Research Study C)

Informant	University/Industry	Job title	Interview length (hh:mm)
N1	University	Head of Unit	00:56
N2	Industry	Project Manager	01:02
N3	University	Research Assistant	00:28
N4	University	Research Assistant	00:19
N5	Industry	Project Manager	00:42
N6	University	Research Assistant	00:33
N7	Industry	CEO	00:46
N8	University	Head of Institute	00:49
N9	Industry	CEO	00:48
N10	University	Research Assistant	00:44
N11	University	Research Assistant	00:34
N12	Industry	Project manager	00:29
N13	University	Research Assistant	00:27
N14	University	Research Assistant	00:26
N15	University	Head of Institute	00:36
N16	Industry	Head of Unit	00:35
N17	University	Research Assistant	00:39
N18	University	Postdoctoral researcher	00:31
N19	University	Research Assistant	00:34
N20	University	Head of Institute	00:43
N21	University	Head of Institute	00:36
N22	Industry	Director	00:45
N23	Industry	Energy Consultant	00:39
N24	Industry	Authorized Signatory	00:29
N25	Industry	Public Employee	00:21
N26	University	Research Assistant	00:35
N27	University	Research Assistant	01:07
N28	Industry	CEO	00:46
N29	University	Research Assistant	00:40
N30	University	Research Assistant	00:24
N31	University	Scientist	01:09
N32	Industry	Project Engineer	00:33
N33	Industry	Municipal Employee	00:53
N34	University	Research Assistant	00:39

Table 11. Sample Structure (Research Study C)

	Total	Details
Interview partners	34	440 pages of transcript
Documents		
Project sketch	1	30 pages
Project proposal	1	343 pages
Project plan	1	Excel file with 12 sub-sheets
Project reports	2	81 pages
Other		Meeting protocols, cooperation agreements

Analytical Approach

We used MAXQDA22 to code the interviews and other data sources. The different kinds of sources at different points in time enabled the reliability and trustworthiness of our findings (Eisenhardt, 1989; Yin, 1994). As we aimed for reliability and validity of our analysis, we followed the approach suggested by Goffin et al. (2019).

For the coding process, we started with first-order codes that represented the actions of the different project actors in the subprojects from the beginning of the project proposal process until one year after the start of the project. We wanted to understand how the actions of completing the project proposal and starting with the project might differ between universities and industry levels. For second-order codes, we relied on the micro-foundations from (Duranton and Puga, 2004) and looked into "sharing," "matching," and "learning" mechanisms for the given time frame (Langley et al., 2013). To ensure analytical quality, we collected feedback from participants by presenting interim results in project meetings. Here, we challenged our understanding with the living lab members and thoroughly discussed our findings with the project partners. Further, we could verify our results through data sources and ongoing data collection.

4.4 Results

This section will explain how the studied living lab evolved under consideration of the micro-foundations of urban agglomeration effects (Duranton and Puga, 2004). Therefore, we will first look at the three mechanisms of sharing, matching, and learning and explain how they apply to the situation concerning the different actors. We will differentiate between universities, industry, and across those actors within each mechanism. In addition, we analyze different points in time where t_1 stands for the project application phase and t_2 for the first year after the project start. Finally, we elaborate on where the agglomeration theory reaches its limits due to sustainability and regulatory reasons. We give an overview of the results in Figure 6.

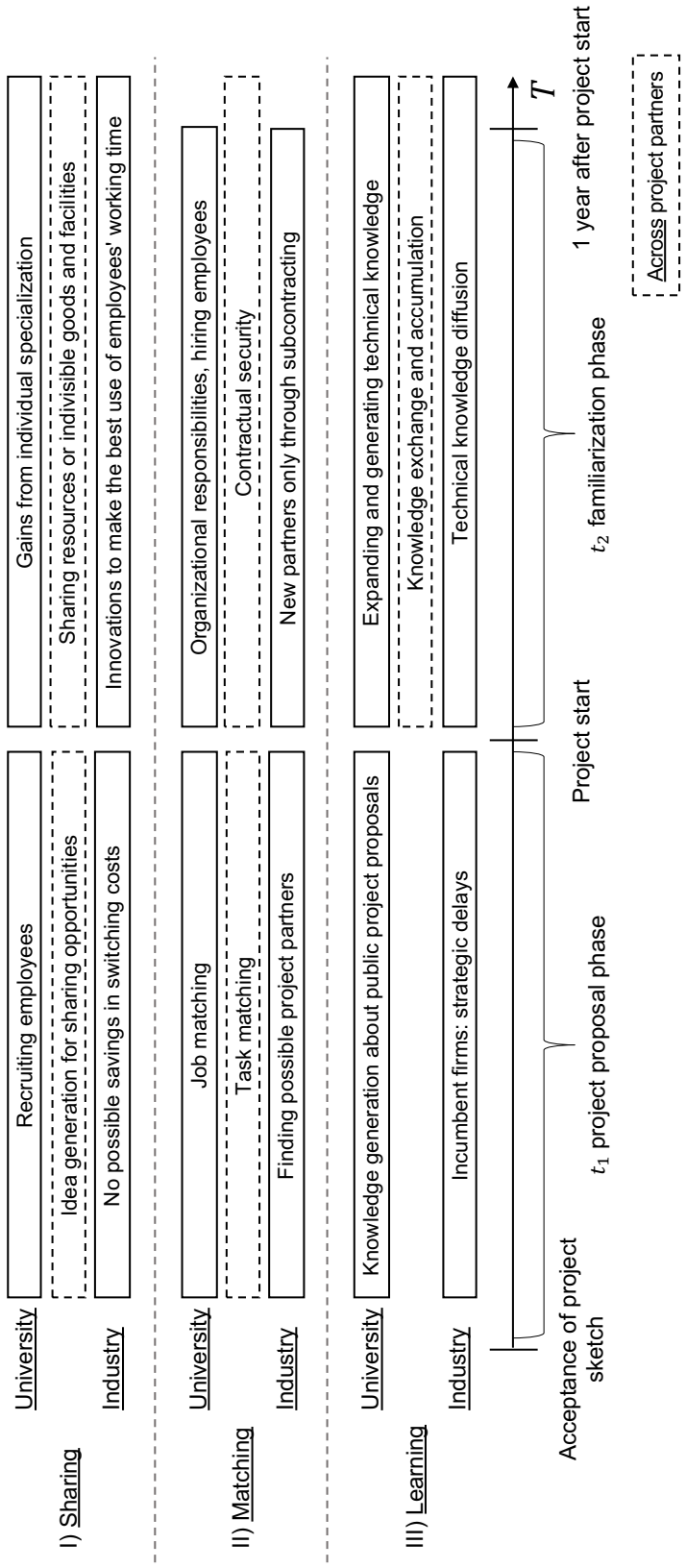

Figure 6. Micro-foundations of agglomeration effects before and after the project started in the living lab (Research Study C)

4.4.1 Sharing in Living Labs

We found micro-foundations of sharing in the living lab. However, the benefits of sharing were not apparent on both sides.

On the university side, institutions could share the gains from individual specialization. In this case, universities recruited people for the living lab, who were then able to specialize in their area of interest. This process was mainly matured on the university side. In addition to administrative staff, primarily scientific staff (e.g., research assistants) was hired, which is often the objective of institutes when participating in research projects (doc). It means that the institutes got "extra workers" that could not only produce more outcomes, but because of the more time spent on the task, they could specialize in the respective fields and increase efficiency. As one person from the university side stated:

And today, and this is also where we come in with the [living lab], the vehicle systems, i.e., mobility and energy systems, are particularly interesting in that they interact very strongly across sectors, and this is also the core competence field which we operate. You said earlier that there is a lot at the system level, which is precisely where we specialize. And that is also my field of expertise, to think on a system level, to think in a superordinate way. (N20)

However, the academic side could not realize the benefit of the gains from specialization until t_2, since at t_1 the tasks for the project proposal came on top of the scientific staff. The academic side will be able to use these gains until the end of the project.

The industry side could not exploit some gains. Even though personnel costs are often a significant cost item for industry partners, which authorities partially fund, this does not always lead to new hires (doc.). Industrial companies, therefore, could not benefit from possible savings in switching costs, but even more, tasks are assigned to an employee because of the living lab. This problem will change little over time as the project plan's funding rate for industry partners is fixed. One employee from a local company explained the situation in t_2 as follows:

And then we could not start with [the living lab] from one day to the next. (…) although there is a personnel cost subsidy, it is so that it does not have a subsidy quota of effectively one hundred percent and is also limited to five years. And that's why it's not so easy to build up more capacities in specialist departments. Yes, the main requirement or the main challenge, especially in the departments, is finding the space and the time to work on the [living lab] topics to the extent that is necessary. (…) But I think that will actually be the main challenge for the next five years. (N12)

Limited capacity can force innovative approaches to best use employees' working time (Duranton and Puga, 2004). The project promotes innovative methods. Project partners will test various formats (such as lessons learned or agile practices) to best use the limited time available to employees. The industry

side can benefit from this and take methods that work for them into everyday work (and beyond project work).

Across the project partners, the living lab enabled sharing resources or indivisible goods and facilities. Some of the subprojects were geographically co-located, so research and implementation of the measures took place within the quarters. For example, one subproject aimed to create an energy-optimized residential quarter. This subproject involved four industry partners and three research institutes in achieving the planned measures (doc.). They must cooperate to work efficiently to implement the different energy measures. One person from the project coordination team explained this phenomenon for district heating in that subproject:

So, whether it is not much more attractive from an urban development point of view, especially in the background of the energy transition, to think about such things together, to create interfaces and to make it possible that waste heat can be used, that we bring together district heating systems, which make sense, especially in urban centers, where we have a tight development, a dense development, for such points. (N9)

Here, the person describes two possibilities for sharing. On the one hand, the idea is that stakeholders share an indivisible good in district heating. On the other hand, the project can only implement this technology across interfaces, which requires the cooperation of several urban actors. Through the living lab, the various stakeholders work collaboratively on new solutions for the implementation, which creates beneficial synergies. Those opportunities to share possible gains made the living lab possible in t_2. In t_1, the project parties laid the groundwork for innovative approaches to sharing indivisible goods. For example, the surplus electricity from the tram network is used to charge electric cars (doc.). This cross-system approach might never have emerged without the living lab.

4.4.2 Matching in Living Labs

Matching can happen through different dimensions. Duranton and Puga (2004) describe the match between a company and potential employees looking for work. Despite job matching, there are further matching dimensions like matching resources or skills (e.g., between task and worker or between company and supplier) (Thummadi and Paruchuri, 2022).

On the university side, the quality and chances of job matching improved through the living lab. This process already started in the project proposal phase t_1. The scientific institutes recruited and prepared most of the scientific employees during the proposal phase. Even though it carried a risk for the possible candidates, it had advantages for the employees and the scientific institutes. First, the candidates could "get a taste" of the subject matter and see if it interested them. For the institutes, the training period (e.g., when students wrote their thesis) did not fall within the project period, and the employees could

start the project directly highly qualified (obs.). One scientific employee told us how he came to the living lab:

And then it came about with the master's thesis, and then the topic was, of course, already very concerted. Also, about the upcoming project (...), which would come later. And accordingly, it just made sense because the know-how was practically already there. And yes, that was the optimal fit with [the living lab]. (...) I was quite lucky. I think that it fits so well with Nut. Yes, that's actually the story, and now I'll probably spend all my time as a doctoral student working on the project because it will last five years. (N3)

After the start of the project in t_2, it was necessary for the academic side to retain employees for the long term who had already been involved in t_1. Financial resources provided by the Federal Ministry enabled the retention of employees as the funding quota for public research institutes comprised 100 % (doc.). Further, the research assistants also took on organizational responsibilities and postulated the subproject management together with the industry. Therefore, the research assistants were involved in task distribution and tried to match and pass on the tasks to suitable employees within their institutes (obs.). Looking ahead to project completion, many doctoral students can start working for companies or found start-ups. Two start-ups were founded by scientific employees from previous projects within the project. Thus, the project creates the basis for further highly qualitative matches.

On the industry side, as described above, most companies did not hire new employees specifically for the project. However, the project enabled partners to find suitable companies already doing relevant work in the field of energy transition but also wanted to align their business models accordingly in the future. Consequently, the living lab attracted the right companies, consisting of established companies and start-ups, for the topics ahead. A manager of a local producing company described how their company's mission aligned with the objectives of the living lab:

We also want to go beyond what we currently do with heat, supply, and electricity generation and be a multimedia supplier. In this respect, this fits very well into our portfolio, and now we'll see the best solution from a levy perspective. (N24)

After the project started in t_2, the consortium could only include companies through subcontracting (doc.). The project had to find appropriate companies committed to it before it started. Project changes in more significant amounts (or even adding new aspects) were hardly possible after the project began. This naturally prevents an optimal resource match during the project duration, especially if further information becomes available after starting the work or if the regulatory environment changes.

Matching across the project partners primarily focused on task matching. At the project proposal phase t_1, the project actors first had to sharpen the tasks they wanted to implement. There were differences between the project sketch and the final project proposal, owing to the diverse ambitions of the research

and industry side. For example, the project sketch listed fewer subprojects than the final project proposal (doc.). Further, some corporate partners were unsure until just before the project started whether they could participate since the money had to be approved by the board of directors (obs.). The dynamics and resulting problems in t_1 describe a project employee as follows:

Initially, it was not yet clear to us what would fit into [the living lab] in terms of content. And the stakeholders, for example, all the companies and industry partners, had to find each other first. But the more we added, the more exciting the topics became. And yes, the crux of the matter was ultimately to mix everything up and build it up again or to structure it, I would say. (N19)

The technological solutions in the project are cross-system. Hence, it is not possible within one company to solve these complex systemic problems. The group of potential matches to solve the technical tasks expands across companies and institutions through the living lab. We observed this advantage, especially in t_2, after the project started and the building of trust through contractual security and the assurance of financial support from the ministry (obs.). However, the project partners needed to create a common language so everyone understood and aligned with the goals. As someone from the project coordination team told us:

In addition to the primary goal of energy efficiency and the subsequent protection of resources and the climate, I believe that another goal is to bring these different disciplines into a dialogue. This is something we don't see very often - at least not in traditional engineering projects - when we try to align so many different sectors to a single goal. And of course, it's fascinating to find the same language for the first time, isn't it? (N8)

4.4.3 Learning in Living Labs

For the learning dimension, we noted a progression over time. First, knowledge generation in t_1 it occurred within the partners. Knowledge diffusion did not happen until later in t_2, when the project partners were contractually bound to each other. Despite the geographical proximity, the partners were cautious about knowledge diffusion, which could be due to the highly regulated energy environment.

On the university side, the project partners generated prominently in t_1 knowledge about public application processes. Since the university is a consortium leader from the start, many suggestions came from this side (obs.). There were not only debates between project partners and public authorities but also negotiations between universities and industry:

The thing was that we first had ideas, or a lot of ideas, and then confronted [the industry partners] with them. And it was less collaboration; it was more unidirectional. And I think that if we had taken them along at an early stage, it might have been a bit easier. And then just the content

development later. But that was simply a bit due to the time. So, everything was very tight because the planning of [the urban district] was already very far advanced. (N17)

Hence, the university side needed to obtain knowledge about the various partners. This knowledge focused at first on methods for developing the project plan and proposal but included technical and especially cross-system knowledge, as the subprojects needed to work in cross-systems. Later in t_2, a dedicated project management team dealt with these methods (doc.). Therefore, the university could get heavily involved in expanding and generating technical knowledge.

On the industry side, we differentiate between incumbent firms (local city economy) and nascent firms (start-ups). In t_1, we could observe a problem of local information diffusion (i.e., strategic delays) described by (Duranton and Puga, 2004). Incumbent companies made their final commitment dependent on other companies (obs., N22), which brought uncertainties and prevented further development ideas for the project proposal. Whereas start-ups saw a chance to gain more knowledge in addition to the financial benefits, incumbents were more cautious. After the project started, companies brought in more specialized personnel (e.g., building services engineers) for the regular subproject meetings and to work on tasks (obs.). A highly controlled industry, predominantly cross-sectional planning, makes knowledge diffusion difficult without contractual commitment. In addition, an employee of a start-up specializing in data platforms explained that customers' data (in this case, tenants) is highly regulated and protected, making it challenging to collect knowledge about user behavior to develop automatic systems (AI learning) further. Although there is a local opportunity to gather or distribute knowledge through a geographically proximate neighborhood, it is often impossible due to the regulatory environment.

Across the project partners, an exchange of knowledge regarding the technical details happened after the start of the project (t_2). The regular various project meetings fostered knowledge diffusion across the different partners. The cross-cutting sessions addressed focus topics to create links between knowledge sources. As one staff member from project coordination explained to us:

The regular exchange that you then have with the individual participants, both professionally and in terms of personnel. That is a very important point. Without [the living lab], you would have to gather everything together somewhere individually. And, of course, what I meant was the possibility of looking at the individual facts again in a larger system. Otherwise, you always have some small test cases where you don't know how they behave in a large overall context. Of course, these are great opportunities to examine this here. (N18)

Project partners could exploit the *accumulation* of knowledge as well. Industry and university partners were able to share prior experience from previous projects, as one of the project members told us:

(...) that is now the challenge in [the living lab], that we really get it implemented with what we have learned in various places before in projects. I do not think that we will have any major scientific

innovations - at least in the areas we are now working on - but that this potential success really lies in implementing it with industrial partners. This cooperation between industry and research is the focus here. (N6)

It implies that project partners adopted previous innovations developed in earlier joint projects to test them on a larger scale. For example, one subproject in the current living lab deals with an integrated system for generating, storing, and networking renewable energies in a neighborhood. This subproject builds on knowledge from a previous research project with similar stakeholders (doc.).

4.5 Discussion and Conclusion

Agglomeration effects enable firms to increase their financial or innovative performance (Carlino and Kerr, 2015). These effects can occur in living labs and benefit the local stakeholders involved. This study aimed to investigate how the micro-foundations of agglomeration developed in a living lab from the start of the project proposal phase until one year after the project started among the different actors.

The results reveal an evolvement of agglomeration effects over time. Similarly, as Mathias et al. (2020) have shown that company age affects the relationship between agglomeration and innovation performance, we found that the project phase had a significant impact. Industry partners of the living lab could experience many benefits only after the project started. Across the project partners, learning could only be fully disclosed after the project partners were contractually bound to each other, as the topics of the subprojects were highly regulated.

This also shows that not every partner could derive the same benefits from the agglomeration effects (Capozza et al., 2018; Orlando et al., 2019). We divided our project participants into universities and industry partners. We found trade-offs between the project partners, arguing that agglomeration can also negatively affect some project partners. For the learning mechanism, we could see that partners that shared knowledge might drive the innovation within the project but gave up a competitive advantage. However, we discovered that the sharing and matching mechanisms can also drive innovation beneath learning, which other literature identified as the primary driver (Carlino and Kerr, 2015).

Finally, the question arises whether agglomeration effects will eventually become saturated since an urban economy cannot add infinite players to the market in a regulated energy industry. For example, grid operators have already divided the German power grid precisely. Therefore, it would not be possible for other players to join, which means that some agglomeration effects are absent. Here, living labs can offer a possibility to still provide access to, for example, gains from specialized workers

(sharing dimension) provided by the university side, even though no further grid operator comes into the market.

4.5.1 Theoretical Implications

This paper yields several contributions to the research streams of living labs and agglomeration effects. First, we expand the literature on the living lab phenomenon (McCrory et al., 2020; Coffay et al., 2022; Fuglsang and Hansen, 2022). We look at underlying processes between actors before the living lab begins. It is a valuable case that can shed light on optimizing the project application process and is one of the first studies that accompanied this process. Furthermore, we considered a living lab that intends to promote the local energy transition. We develop a deeper insight into this complex process and expand the previously "very limited understanding of the dynamic interactions in urban areas" regarding the role of urban labs in the energy transition (Nevens et al., 2013, p. 120). The living lab structures can help convince locally based companies to participate in new innovative projects, but they must also be financially motivated. Nevertheless, new technologies are not the top priority, even for local companies that have to deal with the energy transition from a regulatory point of view. Ultimately, they participated because the project became a priority for city authorities. We could uncover these processes by examining the project proposal phase and incorporating a longitudinal view (Hossain et al., 2019).

We studied micro-foundations of urban agglomeration effects qualitatively to understand better the complex network structure of different partners (Duranton and Puga, 2004). Whereas former research studied similar types of actors like start-ups (Capozza et al., 2018), firms within an industry (Mathias et al., 2020), or universities (Orlando et al., 2019; Schlegel et al., 2021), we included all of them. On the one hand, this aligns with the idea that a joint sustainability transition is only possible with various actors working together (Elzen and Wieczorek, 2005). On the other hand, the different actors influence each other (across types) so that some trade-offs only become apparent when viewed as a whole.

Lastly, we combine the two research streams and thus unfold a more objective view of living labs based on economic theories. Applying approved economic theories to new research niches offers great potential (Thummadi and Paruchuri, 2022). For example, in our case, it made sense that due to the geographic character of urban living labs, some effects can be explained by an urban economic theory and lead to a clearer understanding of why to introduce living labs, particularly on a regional level. As Caragliu and Del Bo (2019) already demonstrated the relevance and raison d'être of smart cities through agglomeration effects, we could expand their research to the relevance of living labs characterized by an experimental character and less by a change through legislation (McCrory et al., 2020).

4.5.2 Managerial Implications

We motivate industry partners to participate in living labs to outsource tasks requiring specialized knowledge through the project. Cross-system solutions are essential for the energy transition. Local

living labs promote cross-sectoral collaboration and enable new innovative approaches to problem-solving. Furthermore, matching the tasks is simplified as the actors are in a contractually secured space and can find suitable people beyond their company to take on tasks.

For policymakers, we recommend setting the funding rate for industry partners right from the beginning of the project proposal phase. Many partners have hesitated with a final commitment (and thus unsettled further partners) because the funding quota regarding personnel costs was not fixed and even decreased until the start of the project. However, trust should prevail on a local level as information diffusion happens.

Living lab organizers should streamline change requests, and the governance of public projects should shift toward a stage-gate framework featuring shorter planning intervals. This adjustment would allow for integrating new project partners at later stages in response to novel change requests for subprojects. Additionally, it has the potential to facilitate job and task alignment.

Lastly, living labs enable stakeholders to exploit cities as experimental spaces (Leminen et al., 2021). However, we explored that the university was driving the project's initiation phase. It might be more challenging to start a living lab with all the vital urban actors without a university actor (who can be fully financially supported through the project). But, the stakeholders involved in the living lab should prioritize citizens' needs. Some initiatives in the living lab rely on adapting citizens' behaviors to optimize energy efficiency, especially in regional projects. Inclusion is, therefore, essential for the co-creation of innovation with citizens, ensuring that the planned measures of living lab partners meet the end user's needs (Gascó, 2017). In the researched living lab, this topic was addressed in a sub-project that explicitly deals with public relations and communication of local citizens. In addition, living lab stakeholders planned measures like surveying the user behavior of tenants.

4.5.3 Limitations and Future Research

Several limitations should be considered while interpreting the results of this study. However, the limitations provide a basis for future research. First, we do not have precise measurement data on the actual project output. The project was not yet completed, and the calculation of possible savings measures (e.g., CO2 savings or flexibility potential) through innovation had not yet been finalized. We further focused on the phase before and shortly after the project started. Future research could develop a metric for this and look more closely at the outcome of completed living labs. In addition, the goal of living labs is to achieve long-term success that has a long-lasting effect on, for example, the city. Long-term consequences of living labs should be a future research area because living labs often deal with sustainability issues, and the changes are not always directly recognizable. Positive effects may disappear after the end of a living lab since the parties are not contractually bound to each other, or the

living lab may have a signal effect so that more companies settle in the area. To some extent, these effects can only be considered quantitatively.

Second, we looked at a specific case of living labs that dealt primarily with topics related to the energy transition. Problems may not be transferable to all living labs, as they have arisen due to the strictly regulated environment. This concern also applies to the geographic nature of agglomeration effects. We studied a specific city with certain characteristics that influenced the development of the living lab. For example, the city inhabits many universities, highlighting the importance of scientific endeavors in that area. Therefore, a cross-case analysis comparing different thematic living labs in different regional settings would help extend the scope of our findings. Even though generalizability is favorable in research, case studies are needed to provide insightful examples of interesting phenomena like living labs (Flyvbjerg, 2006). In our case, we saw that the region, as home to many universities, contributed to the successful start of the living lab. In summary, we conducted a detailed longitudinal study that illuminated the dynamics among various stakeholders within the living lab, which, for example, quantitatively, would have been challenging to attain.

Chapter 5 Research Study D:
The influence of sustainability orientation in innovation portfolios

Abstract:

Organizations increasingly adopt a sustainability orientation in response to pressures from governmental authorities, competitors, and customers. Innovation Portfolio Management has emerged as a critical strategic capability, enabling organizations to adapt to changing conditions and secure competitive advantages through innovation. Strategic orientations significantly shape innovation portfolio decisions, influencing innovativeness and performance outcomes. However, sustainability orientation introduces additional boundary conditions to product development as organizations strive for financial gain and ecological and social sustainability. This research explores the nuanced relationship between sustainability orientation and decision-making in innovation portfolios. We use a multi-informant, cross-industry sample of 115 innovation portfolios to investigate the influence of sustainability orientation on portfolio innovativeness and success. The results demonstrate that sustainability orientation positively relates to portfolio innovativeness. However, portfolio innovativeness only partially mediates the relationship between sustainability orientation and portfolio success. The contributions of this study are threefold. First, our findings underscore sustainability orientation's relevance for portfolio innovativeness and success, adding to the discussion of the degree of innovativeness in sustainable-oriented new product development. Second, the study extends the literature on strategic orientations in innovation portfolio management by introducing sustainability orientation as a new and significant factor influencing portfolio outcomes. Thirdly, the study enhances the conceptualization of sustainability orientation by presenting a comprehensive framework encompassing strategic, structural, and cultural dimensions. This framework fills gaps by providing a more holistic understanding of sustainability orientation in innovation and general management contexts. In challenging the current portfolio process regarding sustainability, we encourage practitioners to incorporate sustainability into innovation portfolio management.

Classification in terms of this dissertation:

- **Tensions:** Paradoxical sustainability tensions
- **Sample:** Multi-informant project portfolio management survey (n=115 portfolios)
- **Method:** Structural equation modeling

Publication and Conferences:

Bechtel, Jadena; Kock, Alexander (2023): The influence of sustainability orientation in innovation portfolios. *Under review (R2) in a leading innovation management journal (VHB A).*

Earlier versions were presented at the International Product Development Management Conference 2022, Hamburg, Germany, where it received the *Christer Karlsson Best Paper Award,* and the European Academy of Management Conference 2022, Winterthur, Switzerland.

5.1 Introduction

Innovation Portfolio Management (IPM), a pivotal strategic capability for organizations, has emerged to adapt to changing conditions and secure and sustain a competitive advantage through innovations (Kester et al., 2011; Killen et al., 2012). Firms' strategic orientations shape innovation portfolios' decisions regarding the type of innovation projects they aim to realize (Spanjol et al., 2012). Therefore, strategic orientations influence portfolio composition and performance (Salomo et al., 2008; Talke et al., 2011). Due to pressure from governmental authorities, the public, and competitive markets, companies endeavor to adopt a new orientation—a sustainability orientation, describing "organizational culture, principles, and behaviors that induce organizational members to be aware of and willing to incorporate and act on a variety of stakeholder- and sustainability-related issues related to their operations" (Du et al., 2016, p. 58), in pursuit of potential competitive advantages (Dixon-Fowler et al., 2012). Research demonstrated that a company's sustainability orientation can entail diverse gains, such as new product development performance (Claudy et al., 2016; Du et al., 2016), business model innovation (Klein et al., 2021), or environmental-related performance outcomes (Cheng, 2018; Jagani and Hong, 2022). Sustainability orientation might also influence decisions in an innovation portfolio as portfolio stakeholders must consider all underlying conditions (Kock and Gemünden, 2016; Kaufmann et al., 2021).

However, the distinction between sustainability and other strategic orientations lies in the latter's emphasis on profit generation and cultivating a competitive advantage (Gatignon and Xuereb, 1997). Sustainability can create tension regarding an organization's competitive strategy, leading to further tensions with the firm's existing products and business models, as firms exhibiting a sustainability orientation also endeavor to achieve ecological and social sustainability, but these endeavors may not invariably yield financial gain and instead add more boundary conditions to product development (Soderstrom and Weber, 2019; Hengst et al., 2020). As sustainability is increasingly becoming a mandatory task companies must consider in their decision-making, there is an ongoing debate on the extent to which firms should embrace sustainability to become innovative (Hahn et al., 2017).

A sustainability orientation becomes particularly evident in innovation portfolio management, which implements a company's innovation strategy. Here, decision-makers select the innovation projects they want to execute (Kester et al., 2011). Former research demonstrated that strategic orientations strongly influence decisions in innovation portfolios (Salomo et al., 2008; Talke et al., 2011; Kock and Gemünden, 2020; Kaufmann et al., 2021). A sustainability orientation could worsen this effect as firms also endeavor to achieve ecological and social sustainability, but these endeavors may not invariably yield financial gain and instead add more boundary conditions to product development (Soderstrom and Weber, 2019; Hengst et al., 2020). It can bring more tensions and trade-offs into decision-making, probably affecting the portfolio process. Yet, it remains unclear if sustainability orientation is

advantageous for innovation portfolios, even though a portfolio lens is critical to review the consequences of sustainability orientation in innovation management.

Second, there is still an assumption that introducing sustainability will lead to further incremental development of products and processes (Bos-Brouwers, 2009). However, it is also plausible that companies may opt for more innovative (radical) projects rather than incremental ones because sustainability challenges the current product and processes. As Hoogendoorn et al. (2020) demonstrated for start-ups, green value creation can increase the innovativeness of start-ups' products. Here, Hoogendoorn et al. (2020) explicitly referred to green value creation, which measures the importance of the start-ups' ecological goals concerning their economic goals. However, sustainability orientation incorporates practices and the importance of sustainability throughout the firm and exceeds green value creation (Claudy et al., 2016; Du et al., 2016; Klein et al., 2021). The effects of a sustainability orientation on portfolio innovativeness (i.e., the overall novelty of innovation projects conducted in an organization) are not thoroughly explored in established companies.

Drawing from the literature on strategic and sustainability orientation, we investigate how a sustainability orientation relates to innovation portfolio decisions regarding the projects' innovativeness (Kester et al., 2011). The literature on sustainability orientation in innovation portfolio management is scarce and, so far, relies on qualitative evidence (Brook and Pagnanelli, 2014). Given IPM's importance for strategy implementation, a more nuanced understanding of sustainability orientation and how it affects portfolio outcomes is necessary. We hypothesize that portfolio innovativeness mediates the relationship between sustainability orientation and portfolio success because it strengthens market and technology knowledge, enabling decision-makers to take a proactive and riskier attitude toward innovation projects. We ask: *How does a sustainability orientation relate to an innovation portfolio's innovativeness and, eventually, success?*

We tested our hypothesis in a cross-industry, multi-informant survey sample of 115 innovation portfolios. Using structural equation modeling, we demonstrate that sustainability orientation is a second-order construct comprising strategic, cultural, and structural dimensions. We find that sustainability orientation, innovativeness, and success are positively associated. Surprisingly, a portfolio's innovativeness only partially mediates the relationship between sustainability orientation and portfolio success. This study's contributions are three-fold. First, we contribute to the literature on sustainability orientation and its relevance for innovations (Claudy et al., 2016; Du et al., 2016; Klein et al., 2021). By demonstrating a partial mediation, we add to the discussion how sustainability orientation can contribute to innovativeness (Paparoidamis et al., 2019; Hoogendoorn et al., 2020). Second, we contribute to the literature on strategic orientations in innovation portfolio management (Salomo et al., 2008; Talke et al., 2011; Kock and Gemünden, 2020; Kaufmann et al., 2021). We extend this literature with a new strategic orientation (i.e., sustainability orientation), highlighting its

importance for portfolio innovativeness and success. Third, we enhance the field of conceptualizing and measuring sustainability orientation, offering a comprehensive framework encompassing strategic, structural, and cultural dimensions. In the realm of sustainability orientation conceptualization, scholars favor ecological aspects yet limit aspects of the triple bottom line of sustainability (Gabler et al., 2015; Cheng, 2018). This framework fills gaps in the existing literature by incorporating strategic dimensions, contributing to a more holistic understanding of sustainability orientation in both innovation (Claudy et al., 2016; Du et al., 2016; Klein et al., 2021) and general management contexts (Hahn et al., 2017). This study encourages managers to incorporate sustainability in innovation portfolios and highlights its relevance for decision-making in organizations.

5.2 Theoretical Framework

5.2.1 Innovation Portfolio Management and Success

IPM constitutes a continuous process entailing the assessment, prioritization, selection, and ongoing monitoring of an organization's innovation projects (Cooper et al., 2001; Kester et al., 2011). IPM primarily aims to maximize the innovation portfolio's value through a well-balanced and strategically aligned set of actions (Kester et al., 2011; Martinsuo and Killen, 2014). To make informed decisions regarding the selection of innovation projects, the innovation portfolio must fulfill specified prerequisites, encompassing the clarity and formality of its processes along with the prevailing innovation and risk climate (Kock and Gemünden, 2016). A defining characteristic of an innovation portfolio is its innovativeness (Schultz et al., 2013), describing the extent to which the portfolio's projects are novel to the market or incorporate new technological attributes; this aspect consequently defines the innovative novelty encompassed within a firm's innovation portfolio (Talke et al., 2011; Kaufmann et al., 2021). Thus, it is a current state of the innovation portfolio.

Strategic decisions influence a firm's innovation activity internally and externally by social and business trends and environmental turbulence (Kock and Gemünden, 2016). To fully disclose strategic opportunities through the innovation portfolio, managers must simultaneously implement a top-down strategy (Meskendahl, 2010) and, especially in increasingly turbulent environments, recognize emergent bottom-up strategy (Kopmann et al., 2017).

Innovation portfolio success comprises multiple dimensions, which differ among studies (Cooper et al., 2001; Kester et al., 2014; Kaufmann et al., 2021). We identify three dimensions that are relevant for sustainability. A portfolio's *average product success* concerns meeting the commercial goals of its products or project outcomes, thus maximizing the portfolio value (Kock et al., 2015). The *future preparedness* indicates that the portfolio aligns with future trends, ensuring the company's long-term

survival (Kaufmann et al., 2021). Finally, the *portfolio balance* describes the composition of the projects in terms of technologies, competencies, and application areas (Cooper et al., 2001).

5.2.2 Strategic Orientations and Sustainability Orientation

Strategic orientations and their relationship to innovation is a widely investigated field. A firm's strategic orientation "represents broad strategic choices and directions" to ensure the company's long-term performance and survival (Spanjol et al., 2012, p. 967). Prominent strategic orientations are entrepreneurial, market, and learning orientation. Those strategic orientations are associated with higher firm performance (Schweiger et al., 2019). But, depending on the type of strategic orientation, their relationship to innovation outcomes is mixed (Spanjol et al., 2012). Different measurements of innovation performances and levels of observation explain these mixed findings (Spanjol et al., 2011; Talke et al., 2011). Strategic orientations shape decision-makers' opinions in innovation portfolios and influence the selection of innovation projects. It can support decisions toward more innovative projects. The rationales behind this phenomenon are multifaceted. Strategic orientations, such as entrepreneurial orientation, propel decision-makers towards elevated levels of risk tasking (Kaufmann et al., 2021). Alternative strategic orientations, such as innovation field orientation or a proactive market and technology orientation, contribute to a portfolio's heightened understanding of customer requirements and expand project possibilities that might not have been contemplated without such orientations (Salomo et al., 2008; Talke et al., 2011).

In recent years, a new strategic orientation, sustainability orientation, has gained significant importance. Besides pressure from governmental bodies, firms recognized opportunities to shift their strategy towards sustainability (Dixon-Fowler et al., 2012). There are diverse meanings and definitions of sustainability. Earlier research referred to sustainability as an environmental concern. But in recent years, practitioners have broadened the concept of sustainability (Bansal and Song, 2017). This study's sustainability incorporates the triple bottom line of economic, environmental, and social concerns (Elkington, 1998). Social and ecological goals are as important as economic ones (Hall et al., 2010). Hence, in contrast to other orientations, firms with a sustainability orientation might not only aspire to superior performance (Gatignon and Xuereb, 1997) but have different motives, such as contributing to society, addressing grand challenges of our time, or retaining their employees. Here, scholars speak of "win-win" or "win-win-win" strategies because a sustainable orientation not only benefits a company's business and its customers but can have an advantageous effect on the environment (Elkington, 1994). Hence, research diversified possible outcomes of a firm's sustainability orientation (Khizar et al., 2021). Besides organizational-level consequences used for other strategic orientations (i.e., NPD success, firm

performance, innovation adoption), researchers investigated outcomes like sustainable practices, individual-level outcomes, or contextual outcomes[3].

In innovation management, scholars primarily investigated the effect of sustainability orientation (also referred as sustainability commitment) on NPD success (Claudy et al., 2016; Du et al., 2016; Jin et al., 2019; Zhao et al., 2021), sustainable NPD (Jagani and Hong, 2022), business model innovation (Klein et al., 2021) and green innovation (Cheng, 2018; Aboelmaged and Hashem, 2019). Besides the direct positive impacts of sustainability orientation, scholars identified processes that uncover the mechanisms by which the positive relationship between sustainability orientation and performance outcomes (i.e., mediating effects) can be explained. Here scholars identified eco-capability (Gabler et al., 2015), other strategic orientations (Klein et al., 2021), knowledge competence (Claudy et al., 2016), customer focus (Du et al., 2016), sustainable new products and byproduct management (Jagani and Hong, 2022) as mediators. Moreover, while not explicitly addressing sustainability orientation, other studies examine companies/start-ups incorporating sustainability into their products or goals. Hoogendoorn et al. (2020) demonstrated that start-ups focusing on ecological objectives exhibit more innovative processes and products. Another study indicated that environmental attributes in products are predominantly adopted when the innovativeness of these attributes is high (Paparoidamis et al., 2019). This study underscores the significance of innovations in sustainable product development. In summary, a sustainability orientation, addressing the triple bottom line, could influence decision-makers' selection of innovation projects and their innovativeness, as former studies demonstrated its advantageous effects.

Scholars conceptualize sustainability orientation on an organizational level and an individual level (Khizar et al., 2022). On an individual level, Kuckertz and Wagner (2010) developed a measuring scale, which is now one of the most commonly used to measure individual orientation. On the organizational level, sustainability orientation consists of multiple dimensions combined into a second-order construct. For example, Roxas and Coetzer (2012) categorize three pillars that describe a company's knowledge, practices, and commitment. In innovation management, multiple researchers use the concept developed by Du et al. (2016), which splits sustainability orientation into two dimensions: how important certain sustainability aspects are to the company and to what degree the company does certain sustainability practices (e.g., Claudy et al. (2016); Cheng (2018); Klein et al. (2021)). Other scholars conceptualize sustainability orientation as one concept combining the abovementioned dimensions (Jin et al., 2019; Zhao et al., 2021). The emphasis of this conceptualization lies in new product development and has, therefore, limited applicability to non-physical products. This conceptualization strongly emphasizes the social and ecological aspects of sustainability. However, Khizar et al. (2022) note integrating the

[3] For an overview of all outcomes, see Khizar et al. (2021).

triple bottom line is essential to achieve a holistic perspective on the concept of sustainability orientation. Other scholars implemented the triple-bottom-line principles (Jagani and Hong, 2022). But generalization proves challenging here, as specific aspects may pertain to physical products or exclusively inquire about a company's voluntary social initiatives.

5.2.3 Concepts of Sustainability in Innovation Portfolios

The significance of sustainability orientation in innovation portfolio management derives from its role in translating strategy into operational endeavors (Meskendahl, 2010). However, its effects on innovation portfolio management, like the innovation project selection, have not been investigated yet. Research has indicated that portfolios, especially for new product development, should be sustainably oriented to balance immediate profitability and enduring success (Villamil et al., 2022). But, former literature on sustainability in portfolio management predominantly offered practical or anecdotal advice on how to incorporate sustainability (Brook and Pagnanelli, 2014; Villamil and Hallstedt, 2020) along with delineating specific criteria for the selection of sustainable projects within portfolios (Ma et al., 2020). A recent review on sustainability in portfolio management reaffirms that a substantial portion of articles revolve around assessing sustainability and its integration into the portfolio management process (Aghajani et al., 2023). In decision systems for product development, scholars stress the imperative of harmonizing sustainability objectives with business goals, facilitated by internal incentives, disincentives, and quantitative decision-support tools (Hallstedt et al., 2010). Further, research on circular economy revealed that a strategic orientation toward circular economy might influence decisions toward innovation projects that mitigate harm and fit more towards the beliefs and values of a circular economy (Gomes et al., 2023). Strategic orientations can influence innovation portfolio outcomes as they shape decision-makers' attention. Most studies found positive effects of strategic orientations on diverse outcomes of innovation portfolios (Salomo et al., 2008; Talke et al., 2011; Kock and Gemünden, 2020; Kaufmann et al., 2021). However, this has not been investigated for a sustainability orientation. We conceptualize sustainability orientation in IPM as three dimensions compromising strategic, structural, and cultural aspects. Former literature guided us on how to apply a sustainability orientation in IPM (Claudy et al., 2016; Du et al., 2016). However, IPM is a more specific field of application than a company's general orientation, so we elaborated constructs from previous literature that preserve the general meaning but fit the IPM context. In former innovation studies, scholars used two dimensions of sustainability orientation, relying on the importance of sustainability orientation for the company and the practices the company implemented (Claudy et al., 2016; Du et al., 2016; Cheng, 2018; Klein et al., 2021). We differentiated the importance of sustainability orientation into two dimensions, reflecting an innovation portfolio's strategic top-down view and the cultural significance (bottom-up view) of sustainability orientation. Adams et al. (2016) emphasize both top-down approaches, such as incorporating sustainability into strategic aspects, and bottom-up approaches, motivating employees to be involved. For sustainability practices, prior research on sustainability

predominantly relied on precise actions such as overseeing a company's product carbon footprint management (Du et al., 2016). Recognizing the diversity of innovation portfolios that extend beyond tangible product innovation, we relied on more general practices. Further, the main activities of IPM are to select and monitor innovation projects (Kester et al., 2011). Therefore, we relied on practices that support the selection measurement, which reviews sustainability criteria.

5.3 Hypothesis

5.3.1 Overview

We argue that a portfolio's innovativeness mediates the relationship between a sustainability orientation in IPM and a portfolio's success. Figure 7 presents the conceptual framework of the study.

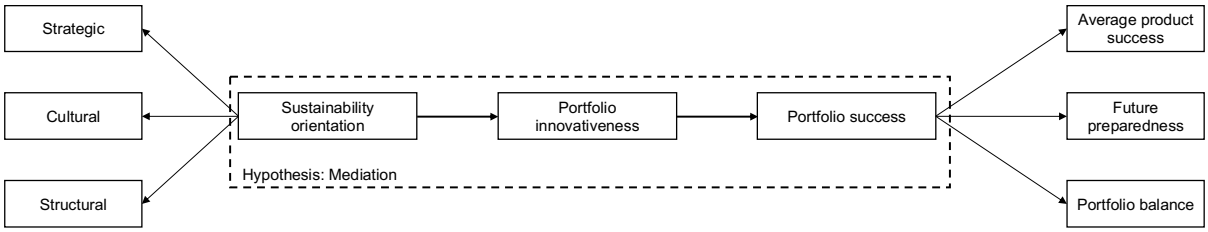

Figure 7. Research model (Research Study D)

5.3.2 The Mediating Role of Portfolio Innovativeness

Strategic orientations can directly or indirectly influence decisions on selecting projects (i.e., strategic response) in an innovation portfolio (Salomo et al., 2008; Kaufmann et al., 2021). We propose that a matured sustainability orientation helps make better and more systematical decisions towards sustainability, opening up new opportunities and providing technological and market newness. We hypothesize that a portfolio's sustainability orientation positively relates to its innovativeness, influencing its success.

Sustainability orientation can create new market opportunities (Dangelico et al., 2013; Klein et al., 2021), possibly leading to more projects within the innovation portfolio that are new to the market. In recent years, customers have demanded more sustainable products, so a sustainability orientation strengthens the need for good market knowledge (Claudy et al., 2016; Paparoidamis et al., 2019). Similar to other orientations, this need could encourage decision-makers in innovation portfolios to "strive more for discovering and satisfying unarticulated, emerging needs of customers" (Talke et al., 2011, p. 823). This orientation could trigger projects targeting a new customer base. Further, sustainable oriented portfolios may also be forced to explore new markets because their current customer base is unwilling to trade another property for sustainable characteristics or pay more for those products (Claudy et al., 2014).

Second, we argue that a sustainability orientation generates additional or entirely new demands, requiring projects to develop substantially new technologies to address these demands and find appropriate solutions. Sustainability orientation can stimulate companies to rethink their traditional processes and products, possibly leading to technological innovations (Nidumolu et al., 2009). The empirical investigation by Klein et al. (2021) revealed that enterprises also become more technologically oriented, which means investing in R&D and engaging with technological trends if they commit to sustainability. New sustainability boundary conditions could trigger this due to regulations (Kassinis and Vafeas, 2006) or company internal restrictions forcing employees to develop new technologies to solve these problems (Hengst et al., 2020). If an innovation portfolio is fundamentally technologically oriented, decision-makers tend to select more technologically new products (Talke et al., 2011). Therefore, we think a sustainability orientation positively relates to the technological innovativeness of an innovation portfolio.

Portfolio innovativeness is then, in turn, positively related to its success (Salomo et al., 2008; Kaufmann et al., 2021). We posit that portfolio innovativeness mediates the relationship between sustainability orientation and portfolio success (i.e., the average product/project success, future preparedness, and balance). Innovative products that are new to the market can position a company where only a few or no competitors can take market share. Similarly, technological innovations might offer a great utility that customers desire, of which competitive products are incapable. The firm can then appropriate this created value, gaining an image as a technological leader (Kock et al., 2011) and increasing profit. Many scholars in innovation management have previously showcased that a sustainability orientation positively affects new product development success (Claudy et al., 2016; Du et al., 2016; Jin et al., 2019; Zhao et al., 2021). The underlying argumentation is that "integrating social and environmental concerns into NPD can lead to competitive advantage through a first mover strategy in emergent "green" markets" (Claudy et al., 2016, p. 75). Therefore, we think it will increase the average product or project success.

Employees and decision-makers in future-oriented portfolios possess the traits to enhance and optimize their existing capabilities as they remain unsatisfied with the current status quo (Gemünden et al., 2018). The idea of sustainability itself implicates the importance of future generations (Brundtland, 1987). Hence, a sustainable orientation could enhance clarity regarding a long-term direction within an innovation portfolio. Since radical innovation enables entry into new markets, firms are prepared to handle future uncertainty (Leifer et al., 2000). Similarly, a technology orientation enabled through sustainability leads to "an opportunity-seeking, forward-looking perspective" within the innovation portfolio (Talke et al., 2011, p. 822). Here, innovation portfolios with a sustainability orientation take a long-term view of their customers, as they might lose customers short-term. Consequently, decision-makers choose projects that contribute to achieving this objective.

In many innovation portfolios, an imbalance prevails between exploration and exploitation because they primarily focus on incremental product improvement rather than risking more extensive change and new competence building (Uotila et al., 2009; Si et al., 2022). So, increasing the share of innovative projects through exploration can build a portfolio balance between existing business fields and new ones as the firm develops new knowledge (Salomo et al., 2008). Through explorative activities, decision-makers take on more risks within the portfolio. A sustainable orientation can contribute to adopting a more risk-tolerance attitude (Klein et al., 2021).

In conclusion, we propose that a sustainably oriented portfolio also tends to select more innovative projects toward the market and technologies, which positively relate to portfolio success dimensions. The latter relationship has been demonstrated already in research (Hult et al., 2004; Salomo et al., 2008; Talke et al., 2011; Kaufmann et al., 2021). Therefore, we hypothesize the following mediation:

Hypothesis: Portfolio innovativeness mediates the relationship between sustainability orientation and portfolio success.

5.4 Methodology

5.4.1 Sample

To test our hypothesis, we decided on a survey-based research design. We surveyed three different informants for each portfolio. First, since we research strategic decisions about the selection of innovation projects and the strategic orientation of portfolios, decision-makers (i.e., senior management) seem an appropriate choice as they are involved in strategic processes (Kaufmann et al., 2021). Thus, we surveyed a senior manager (e.g., head of R&D, division head, or CEO) with decision-making authority involved in selecting and terminating projects and who is a member of the steering committee. Second, we included a portfolio manager (e.g., innovation manager, head of PMO, or portfolio manager) with a good overview of the innovation portfolio, as they are then responsible for executing the decisions made by senior management (Kock and Gemünden, 2020). Third, strategic orientations also reflect the organizational culture (Du et al., 2016), so we incorporated the view of lower hierarchy employees, in our case, innovation project managers (median of three per portfolio) leading some of the portfolio's projects. To collect the survey data, we invited 500 medium- to large-sized organizations by email. This deliberate effort to include a variety of industries and organizational sizes aimed to enhance the external validity of our findings. By considering the perspectives of organizations with distinct characteristics, we aimed to capture a broader spectrum of practices and experiences, thereby contributing to the generalizability of our results. In follow-up calls, we informed the companies about the study design. After the companies had registered, we sent personalized links to the portfolio manager. Every portfolio received an ID to anonymize the portfolio and to be able

to match the answers of the coordinators, decision-makers, and project managers afterward. If only one of the informants (decision-maker or coordinator) filled out the survey, we did not include this portfolio in the sample. Respondents from 141 companies (response rate of 28.2%) answered, but not every company delivered completed surveys for every informant. The final sample comprises 614 respondents (115 portfolio coordinators, 115 portfolio decision-makers, and 384 project managers) from 115 innovation portfolios (an average of 5.9 respondents per portfolio). Table 12 provides sample characteristics (industry, revenue, employees, and portfolio budget).

Table 12. Sample characteristics. (Research Study D)

Industry		Employees	
Mechanical and vehicle engineering	21.74 %	<500	24.35 %
Electrician/ Electronics technician/ ICT	15.65 %	500-2000	29.57 %
Banks/ Insurances	14.78 %	>2000	46.09 %
Traffic/ Transport/ Logistics/ Construction	12.17 %		
Healthcare	8.7 %		
Chemistry/ Pharma	7.83 %		
Other	19.13 %		
Revenue		**Portfolio Budget**	
<100 mil. EUR	18.26 %	<10 mil. EUR	20.87 %
100-500 mil. EUR	20.87 %	10-30 mil. EUR	27.83 %
501-2000 mil. EUR	18.26 %	30-100 mil. EUR	18.26 %
>2000 mil. EUR	42.61 %	>100 mil. EUR	33.04 %

5.4.2 Measurement

For the analysis, where possible, we used multi-item scales from existing literature to measure the variables (Hair et al., 2017). Unless otherwise stated, the items used seven-point Likert scales ranging from 1 ("strongly disagree") to 7 ("strongly agree"). To reduce possible common method bias, we applied several measures ex-ante and ex-post as recommended in the literature (Podsakoff et al., 2003; Chang et al., 2010):

First, we used different informants to determine the independent, mediator, and dependent variables. We aimed to identify the informant with the most informative power in each portfolio to answer our questions and wanted to reduce overly strong opinions. Therefore, we averaged multiple informants' responses (for example, the decision-maker and coordinator assessed the success dimensions).

Second, to implement psychological and proximal separation, we chose informants to assess the study's variables and many other variables. The participants could not identify the relationships between the variables while answering the questionnaire. Further, we physically separated the independent, mediator, and dependent variables in the survey. Additionally, the variables were part of an overall

innovation portfolio assessment, in which the overall focus did not refer to our research questions, hypothesis, or variables.

Third, we protected informants' anonymity by telling participants before registration to reduce a potential social desirability bias and, at the start of the survey, confirming that their responses would be anonymized and only analyzed in an aggregated form. We also emphasized the importance of allowing the project managers to answer honestly since they are usually lower in the hierarchy than the other two informants. Therefore, we required the participation of multiple project managers per portfolio so that responses could not be related to specific persons. Additionally, we explained to the participants the value of an honest answer rather than 'hiding' weaknesses or difficulties.

Finally, we structured statements objectively to improve our scale items (e.g., "There are projects in our project portfolio that primarily address sustainability issues."). We also applied the referent-shift consensus model by Chan (1998), a good instrument for measuring constructs that assess individuals and measure organization-level perceptions (Globocnik et al., 2022). Therefore, we rephrased items to read, for example, "Employees *in our company* have understood what sustainability means for our company," thereby shifting respondents' perceptions from individuals to an organizational level.

Dependent variable: The innovation portfolio success dimensions (average product success, future preparedness, and portfolio balance) are widely established in the former literature (Jonas et al., 2013; Kock et al., 2015; Kaufmann et al., 2021). We incorporated portfolio success as a second-order construct into the model. The *average product success* was measured by a three-item scale reviewing whether the products, on average, met planned market goals, profitability goals, and payback period ($\alpha = 0.850$). For *future preparedness* (three items), we measured whether a company is future-oriented through its technologies, products, and projects ($\alpha = 0.861$). For *portfolio balance,* we used a four-item scale on whether the portfolio projects balance risk and returns, new and existing applications, technology, and competence areas ($\alpha = 0.876$). Portfolio coordinators and senior managers assessed the three dimensions. The correlation of portfolio success between decision-makers and portfolio managers is 0.458, which is acceptable. We, therefore, averaged their responses, which also assured a more balanced evaluation across hierarchical levels.

Mediator variable: We took the six-item scale for portfolio innovativeness from former literature (Talke et al., 2011; Schultz et al., 2013; Kaufmann et al., 2021) and slightly adapted it to fit our context better. Before rating the items, we reminded respondents to answer for their respective innovation portfolios. It incorporates market and technological aspects of a portfolio's innovativeness ($\alpha = 0.845$). The coordinator informant assessed these items.

Independent variable: We operationalized sustainability orientation as a second-order construct consisting of three first-order dimensions: strategic, cultural, and structural sustainability orientation.

Following former scholars, we incorporated sustainability orientation into a second-order construct predicated on two rationales. Chen et al. (2005) recommend applying a second-order model when lower-order factors exhibit significant correlations and when a logical higher-order factor can encapsulate shared characteristics among these lower-order factors. First, the correlations among the three dimensions are high despite stemming from different informants (see Table 2). The second reason negates the necessity of individual dimensions as we advocate that a comprehensive understanding of sustainability orientation integrates these dimensions and that they all positively relate to innovativeness and, eventually, success. Thus, we use a higher-order factor (sustainability orientation) accounting for its dimensions (strategic, structural, cultural). We incorporated a holistic view from different informants for sustainability orientation. The strategic sustainability orientation is a three-dimensional construct that describes whether the company considers sustainability aspects in its strategy and updates it regularly ($\alpha = 0.914$). For the strategic (top-down) element, we asked senior managers to assess the items as part of the strategy formulation process. Cultural (bottom-up) sustainability orientation is a three-item scale indicating whether employees understand what sustainability means and whether sustainability plays an essential role in the portfolio ($\alpha = 0.843$). Here, we asked project managers and portfolio coordinators to answer questions and calculated the items' mean value for each portfolio. Third, we asked portfolio coordinators whether they used control indicators regarding sustainability for project selection and success. We then built a construct based on whether they use neither (0), only one aspect (1), or both aspects (2). Table 2 shows that the three variables correlate strongly even though we used different informants for the first-order constructs.

Control variables: We included control variables that might influence the independent, dependent, or mediator variables. The *formalization* of portfolio management is a four-item scale ($\alpha = 0.895$) from Teller et al. (2012), reflecting the overall IPM maturity. Formalization should be excluded as an alternative explanation because more mature organizations are typically more successful (Teller et al. 2012) and more likely to consider sustainability orientation. Portfolio coordinators assessed this variable. Further, we included the *size of the company* as the natural logarithm of the number of employees because larger companies might have more capacity to integrate sustainability and be more successful. We measured the relative *share of IT/organizational change projects* in the portfolio (vs. other types of innovation projects) because different portfolio types could also have different degrees of innovativeness. Last, we asked portfolio coordinators how strongly external regulatory requirements regarding sustainability influence their portfolio planning (one item), as strongly regulated companies naturally integrate more sustainability measures into their portfolios (Kern et al., 2019). Table 14 shows all variables' item wording, and Table 13 shows their correlations and descriptives.

Table 13. Descriptives and Correlations. (Research Study D)

Variables	M	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Strategic sust. orientation	5.37	1.37	.88									
Cultural sust. orientation	4.18	1.05	.41	.85								
Structural sust. orientation	1.62	0.78	.28	.54								
Portfolio innovativeness	3.84	1.08	.32	.21	.17	.69						
Average product success	4.34	0.87	.39	.36	.20	.32	.85					
Future preparedness	4.79	0.94	.48	.44	.29	.55	.46	.84				
Portfolio balance	4.73	0.74	.38	.41	.17	.41	.63	.58	.83			
Formalization	5.03	1.44	.07	.12	.01	.30	.10	.12	.34	.82		
Firm size	7.29	1.89	.12	.03	.00	-.20	.09	-.02	.14	.10		
Share of IT/ org. projects	35.31	37.13	-.02	-.25	-.15	.13	.11	-.13	-.01	.08	-.01	
Sustainability regulations	3.98	1.66	.09	.26	.19	-.00	.03	.08	-.02	-.03	.03	-.15

N = 115 innovation portfolios; M = mean; SD = standard deviation; sust. = sustainability; org. = organization; $\sqrt{AVE}$ in diagonals where applicable; all correlations above .19 are significant at the 5%-level.

Table 14. Survey Items. (Research Study D)

Construct	Informant	Items	lambda
Sustainability orientation (2nd order construct)			
Strategic sustainability orientation	Senior manager	Sustainability plays an important role in our strategy formulation.	.85
($Alpha = 0.91$; $AVE = 0.78$; $CR = 0.91$)		We actively try to formulate a sustainable strategy for our company.	.91
		We regularly review which strategic aspects we can make sustainable in the company.	.88
Cultural sustainability orientation	Coordinator/ Project manager	Employees in our company have understood what sustainability means for our company.	.90
($Alpha = 0.84$; $AVE = 0.72$; $CR = 0.88$)		Sustainability is an important criterion in project selection.	.91
		There are projects in our project portfolio that primarily address sustainability issues.	.71
Structural sustainability orientation	Coordinator	Which of the following aspects are covered by explicit sustainability criteria (e.g., specific KPIs)? (Multiple answers possible.)	.95
		Project selection	
		Project success measurement	
Portfolio innovativeness	Coordinator	Our products/project results ...	
($Alpha = 0.85$; $AVE = 0.48$; $CR = 0.85$)		... offer new customer benefits which were not previously provided by any other products.	.64
		... create a completely new market.	.64
		... completely change the way our market functions.	.72
		... are based on new technological principles.	.80
		... use new technologies that make older technologies obsolete.	.65
		... use technologies that enable leaps in performance.	.69

Portfolio success (2nd order construct)			
Product success	Coordinator/ Senior manager	Our products/project results of this project achieve the planned market goals (e.g., market share).	.73
($Alpha = 0.85$; $AVE = 0.73$; $CR = 0.89$)		Our products/project results achieve the planned profitability goals (e.g., ROI).	.95
		Our products/project results achieve the planned payback period.	.86
Future preparedness	Coordinator/ Senior manager	We develop new technologies and/or competences in our projects to succeed in the future.	.73
($Alpha = 0.88$; $AVE = 0.71$; $CR = 0.88$)		Our projects for new products, technologies, or services take us a step ahead of our competition.	.89
		The projects enable us to shape the future of our industry.	.90
Portfolio balance	Coordinator/ Senior manager	There is a good balance in our project portfolio ...	
($Alpha = 0.88$; $AVE = 0.69$; $CR = 0.87$)		... between new and existing areas of application.	.82
		... between new and existing technologies.	.92
		... between projects that develop new competences and projects that utilize existing competences.	.73
Regulations	Coordinator	Please assess how strongly external regulatory requirements regarding sustainability influence your portfolio planning.	.95
Formalization	Coordinator	Essential project decisions are made in clearly defined portfolio meetings.	.60
($Alpha = 0.88$; $AVE = 0.67$; $CR = 0.89$)		Our project portfolio management process is divided in clearly defined phases.	.81
		Our process for project portfolio management is clearly specified.	.94
		Overall, we execute our project portfolio management process in a well-structured manner.	.89

5.5 Analysis and Results

We used covariance-based structural equation modeling (SEM) in Stata 16 to calculate the measurement model and to test our hypothesis. Figure 8 includes second-order factor loadings for sustainability orientation and portfolio success and all path coefficients of the SEM because we included the measurement and structural model in one SEM. Further, to test our mediation hypothesis, we bootstrapped the SEM estimation for the indirect effect with 5,000 repetitions (Hayes and Preacher, 2014).

5.5.1 Measurement Model Results

First, we validated the measurement model. We use the cut-off criteria from Hu and Bentler (1998) to assess the goodness of our measurement model with the root mean square residual error (RMSEA), the standardized root mean square residual (SRMR), and the comparative fit index (CFI). Overall, the model had an acceptable fit ($\chi^2[df = 354] = 520.87$; $RMSEA = 0.062$; $SRMR = 0.085$; $CFI = 0.913$).

For the constructs' scale reliability, convergent validity, and internal consistency, we measured Cronbach's Alpha, accepting values larger than 0.7 (Hair et al., 1998), the average variance extracted, and composite reliability, respectively (Ahire and Devaraj, 2001). We accepted values larger than 0.7 for the composite reliability and larger than 0.5 for the average variance extracted (Fornell and Larcker, 1981). The values hold except for portfolio innovativeness, where the AVE is 0.48. However, the composite reliability is still satisfactory and above 0.8. To assess discriminant validity, we relied on the Fornell-Larcker criteria stating that the $\sqrt{AVE}$ of a construct should be larger than its correlation with every other construct in the model (Fornell and Larcker, 1981). We added the $\sqrt{AVE}$, where applicable, on the diagonal of the correlation table (Table 13) and could confirm discriminant validity. All items loading and their respective criteria can be found in Table 13.

The three dimensions of strategic (second-order factor loading λ=.567; p=.000), cultural (λ=0.867; p=.000), and structural orientation (λ=0.611; p=.000) load strongly on sustainability orientation, confirming the construct's second-order nature. Further, the three dimensions of portfolio success, average product success (λ=.567; p=.000), future preparedness (λ=0.867; p=.000), and portfolio balance (λ=0.611; p=.000) load strongly on portfolio success.

5.5.2 Structural Model Results

Figure 8 presents the results of our hypothesis testing and all other path coefficients of the SEM. The explained variances for the endogenous constructs are $R^2 = 0.295$ for portfolio innovativeness and $R^2 = 0.755$ for portfolio success. We hypothesized that portfolio innovativeness mediates the relationship between sustainability orientation and portfolio success. In the first step, we examine the direct effects of the mediation. We can confirm that sustainability orientation positively relates to portfolio innovativeness (path coefficient $\gamma = 0.381; p = .001$) and that portfolio innovativeness is significantly related to portfolio success ($\gamma = 0.533; p = .000$).

In the second step, we must test for the indirect effect of sustainability orientation on portfolio success. Therefore, we followed the approach suggested by Hayes and Preacher (2014). The indirect effect (i.e., the distribution of the product of the path coefficients) is not normally distributed, which is why we bootstrapped the standard error for the indirect effects with 5,000 repetitions. Here, the indirect effect of sustainability orientation on portfolio success through portfolio innovativeness is significant ($\gamma = 0.145; p = .035$) with confidence intervals between 0.01 and 0.28 on a 95% level. Considering that the residual direct effect of sustainability orientation is also significantly related to portfolio success ($\gamma = 0.548; p = .000$), we conclude that sustainability orientation is partly mediated by portfolio innovativeness.

In conclusion, our results show that portfolios with sustainability orientation also directly relate to portfolio success. Besides the effect of sustainability on portfolio innovativeness to select projects that

are new to the market and handle new technologies, which in turn influence a portfolio's success, there might also be other explanations for why sustainability orientation relates to success directly. We will discuss our findings in the discussion.

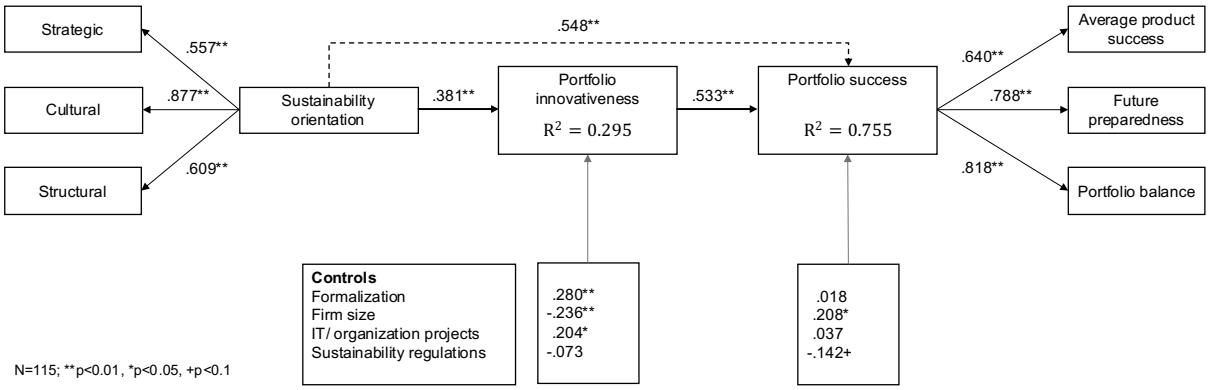

Figure 8. Results of the Structural Model. (Research Study D)

5.5.3 Robustness Tests

One could also assume reversed causality, and innovativeness precedes sustainability orientation. To exclude this alternative explanation, we followed a methodological approach. We used another data set from a former study (T_1, three years before) where we measured the portfolio innovativeness. Matching the two data sets, we only have an overlap of 30 innovation portfolios. The correlation between innovativeness in T_1 and the sustainability orientation from the current study T_2 is $r = -0.024$ ($p = 0.8994$), which indicates no effect of innovativeness on sustainability orientation. Further, we have a third data set from a later study (T_3, two years after) that also measured innovativeness. The overlap between the study with sustainability orientation in T_2 and the later study in T_3 is 33 portfolios. Here, the correlation between sustainability orientation and innovativeness is $r = 0.327$ ($p = 0.0675$), indicating a significant relationship. Due to the reduced sample, this is an indication of our hypothesized argumentation but no demonstration. However, it could be that portfolios, just because they select more innovative projects, will not necessarily turn to sustainability later, but sustainable portfolios may become more innovative later.

5.6 Discussion

A sustainability orientation is a strategic orientation in which decision-makers and employees consider sustainability issues for organizational activities (Claudy et al., 2016; Du et al., 2016; Klein et al., 2021). Strategic orientations serve as directives for harmonizing a company's endeavors with them, thereby substantiating their influence over the selection of projects within the innovation portfolio (Salomo et al., 2008; Talke et al., 2011). This study finds that companies with a high sustainability orientation

select more innovative projects in their innovation portfolio and have higher innovation portfolio success.

The findings extend prior research on sustainability orientation and its benefits for organizations regarding their new product development (Claudy et al., 2016; Du et al., 2016; Jin et al., 2019; Zhao et al., 2021). By integrating sustainability into decision-making processes, projects receive sufficient freedom and resources to build new knowledge on sustainability, leading to more innovative technological products or processes. The novel orientation may additionally result in the expansion into untapped markets facilitated by enhanced competency of customers. At the portfolio level, strategic decision-makers select and prioritize innovation projects (Kester et al., 2011). These decisions are not isolated choices; instead, they have a profound impact on the entire organization. The innovation portfolio, as the summation of chosen projects, aligns with the organization's broader goals. A sustainability orientation at this level ensures that the projects selected contribute not only to innovation but also to the company's environmental, social, and economic objectives. The impact is not limited to a singular project or team; rather, it permeates the organizational ecosystem, fostering a culture of sustainability that extends beyond individual initiatives.

Nevertheless, the mediation is partial and does not fully explain the effect. Therefore, there must be additional effects that explain the impact of sustainability orientation on the portfolio beyond selecting more innovative projects. First, sustainability orientation could directly influence portfolio success. Former studies argued that sustainability leads to operational efficiencies that save resources and enhance new product success (Claudy et al., 2016; Klein et al., 2021). In an innovation portfolio, those savings could also apply to the average project success, especially when considering the cultural dimension of sustainability orientation when employees understand the topic well and can act accordingly. Moreover, in recent and upcoming years, sustainability regulations (e.g., EU reporting requirements) have been and will continue to prompt companies to change their activities (Lindberg et al., 2019). Sustainably oriented portfolios can, therefore, proactively respond to regulatory shifts rather than reacting under duress. By prioritizing sustainable solutions in product development, processes, and services, innovation portfolios inherently adhere to the regulatory requirements in advance, circumventing potential disruptions (Kassinis and Vafeas, 2006). Therefore, sustainability orientation might also directly relate to the future preparedness of the portfolio (Villamil and Hallstedt, 2018).

A second reason could be that sustainability orientation is contingent upon additional factors within the innovation portfolio and its environment. Researchers found that strategic agility influences environmental innovation (Bouguerra et al., 2023). This association arises from continuously monitoring organizations' internal and external environments, facilitating responsiveness to changes. Consequently, companies with strategic agility are credited with fostering enhanced resource management, a pivotal aspect of ecological sustainability. In innovation portfolio management, agility

is a crucial capability to keep the innovation portfolio strategically aligned (Kock and Gemünden, 2016). Possibly, the hypothesized mediation in this study may be moderated by the strategic agility of the innovation portfolio, as it facilitates the optimal selection of resources and projects aligned with the strategy. Additional contingency factors could influence the mediation. Although we have controlled for pressure from various stakeholders and markets, this could also be a contingency factor. Increased pressure from all groups could lead to a more proactive strategy in responding to this pressure (Murillo-Luna et al., 2008). Possibly, decision-makers select more innovative projects due to sustainability orientation if they feel high pressure from stakeholders. Lastly, the managers' reactions could also depend on the industry or the type of innovation portfolio. Although Hoogendoorn et al. (2020) demonstrated that the effect of green orientation on innovation outcomes in start-ups does not depend on industry, it could be different for innovation portfolios placed in established companies. Here, companies may not have the motivation as start-ups to select exploratory projects (Teece, 1986). Innovation portfolios in less turbulent industries may then select more incremental innovation projects to implement the sustainable orientation.

5.6.1 Theoretical Implications

We offer novel insights into the research fields of sustainability orientation and innovation portfolio management. First, we shed light on the relevance of sustainability orientation for decision-making regarding the degree of novelty of projects. Hoogendoorn et al. (2020) demonstrated that, regardless of the type of innovation, green value creation contributes to the innovativeness of start-ups' products. In contrast to the assumption that sustainability leads to incremental improvements (Bos-Brouwers, 2009), we could confirm that decision-makers, incorporating the triple bottom line, are drawn to more innovative projects in sustainable-oriented portfolios. For a firm context, the inherent constraints of incorporating sustainability considerations into a company's products and projects act as catalysts for novel ideation, fostering the exploration of new technological avenues and the identification of unexplored market opportunities. Furthermore, we confirmed the benefits of a sustainability orientation in innovation management (Claudy et al., 2016; Du et al., 2016; Klein et al., 2021). Innovation portfolios, in particular, benefit from a sustainability orientation and are associated with enhanced performance, primarily, though not exclusively, driven by the heightened innovativeness of the projects. This study contributes to the general view that to remain competitive in the long term, companies need to incorporate sustainability into all organizational levels. Thus, besides sustainability orientation's advantages for new product development success (Claudy et al., 2016), it promotes a long-term orientation of a company's stakeholders (Hahn et al., 2014; Neugebauer et al., 2016).

Second, we contribute to the literature on strategic orientations in innovation portfolio management by finding first insights into why innovation portfolios should incorporate sustainability. Our empirical results demonstrate that sustainability orientation is positively related to innovation portfolio outcomes.

To our knowledge, this is the first study to empirically investigate sustainability orientation in innovation portfolio management. Former research in IPM acknowledged the importance of strategic orientations for portfolio success outcomes (Salomo et al., 2008; Kock and Gemünden, 2020) and portfolio innovativeness (Talke et al., 2011; Kaufmann et al., 2021). The argumentations for the positive effects of those orientations (e.g., entrepreneurial orientation, innovation field orientation, and innovation orientation) are diverse. However, a joining element across these orientations is the shared emphasis they add to a comprehensive understanding of market dynamics and necessary technologies. We add to this argumentation because sustainability orientation catalyzes recognizing nascent trends and paradigms (Claudy et al., 2016; Du et al., 2016). By prioritizing sustainable practices and considering their implications, innovation portfolios gain insights into evolving consumer preferences, regulatory shifts, and emerging societal expectations. This proactive stance allows for identifying novel opportunities and realigning innovation initiatives to embrace these emerging trends, contributing to portfolio success. However, innovation portfolios with a sustainability orientation strive for competitive advantage and encompass a broader commitment to societal and environmental contributions (Gatignon and Xuereb, 1997). In this context, this orientation deviates from those previously investigated in IPM. It is conceivable that this sustainability orientation might yield unfavorable consequences for portfolio decisions and their outcomes. Here, we found evidence that sustainability orientation has a more complex relationship to a portfolio's innovativeness than initially expected. Therefore, we add to the literature of IPM that demonstrated the importance of strategic orientations (Salomo et al., 2008; Talke et al., 2011; Kock and Gemünden, 2020; Kaufmann et al., 2021).

Lastly, we contribute to developing a conceptualization for sustainability orientation considering the triple bottom line of sustainability and all types of projects besides developing physical products, answering the call for future research to generalize sustainability orientation to quantify better and compare sustainability practices (Khizar et al., 2022). Former literature incorporated mainly environmental or social aspects into sustainability orientation (Gabler et al., 2015; Cheng, 2018; Jin et al., 2019) or placed a strong emphasis on physical new product development (Claudy et al., 2016; Du et al., 2016; Klein et al., 2021). In IPM literature, prior research focused on supporting decision-making processes with sustainable indicators (Brook and Pagnanelli, 2014; Sánchez, 2015) but fell short on cultural or strategic sustainability dimensions. We conceptualize sustainability orientation with a strategic, structural, and cultural dimension, combining previous literature findings and propagating a holistic view of sustainability orientation (Hahn et al., 2017).

5.6.2 Managerial Implications

The study provides insights and practical implications for managers. First, we found that innovation portfolios must holistically incorporate a sustainability orientation. Therefore, we encourage decision-makers and portfolio coordinators to commit to sustainability on all levels (strategic, cultural, and

structural). In detail, senior management must establish a sustainability strategy, paying careful attention when an explicit strategy competes with a meaningful traditional business strategy, as former research found detrimental decoupling processes when integrating a separate sustainability strategy (Hahn et al., 2017; Hengst et al., 2020). Therefore, organizations should determine whether reformulating the current innovation strategy toward more sustainable actions is viable. Further, it remains vital that employees understand the relevance of sustainability for the company. To establish a sustainability culture, top-level managers should create opportunities for employees to participate and share their values and understanding of sustainability actively (Adams et al., 2016). Lastly, senior management needs to walk the talk. Thus, structural sustainability orientation through sustainable performance control on the project and portfolio level is indispensable. Portfolio coordinators can support senior management by providing useful key performance indicators and appropriately adapted project selection processes. However, not every portfolio coordinator is a sustainability expert. Therefore, the organization should provide training regarding sustainable action. Sustainability orientation itself has a positive relation to the overall portfolio success. Due to sustainable development being long-term oriented, companies should not ignore sustainability topics. Although innovation portfolios in some industries do not strive for sustainability, a sustainability orientation could safeguard the company's long-term survival.

5.6.3 Limitations and Future Research

Our study has some limitations, so the results must be interpreted cautiously. Nevertheless, they can build the basis for future research. First, although we reduce common method variance through a multi-informant study design, the hypothesis testing is still based on correlational evidence. We selected knowledgeable informants within the portfolio who could provide the most informative insights to our questions. This decision (which informant can answer which questions in the portfolio) is subject to assumptions that may not necessarily hold true in reality. Informants might have responded based on social desirability, and while we acknowledge this, averaging specific responses, such as the success assessment, is intended to mitigate these effects. Additionally, the multi-informant design allows us to integrate multiple perspectives and further reduce common method bias.

Further, we cannot entirely deny endogeneity concerns. The cross-sectional nature of the sample, which provides data at a specific point in time, constrains our ability to establish causal relationships or capture the dynamic evolution of variables over time (Bowen and Wiersema, 1999). Future research endeavors incorporating longitudinal data or instrument variables may offer a more comprehensive understanding of the nuanced relationships identified in this study. Expressly, we cannot exclude reversed causality as successful companies have more capacity to deal with additional issues such as sustainability. We found an indication for our hypothesized relationship as we tested for correlations in three studies with different time points, but further studies are needed to rule out endogeneity.

We propose that sustainability leads to more decisions toward radical innovation projects. As we found a positive correlation and a partial mediation, we found an indication for our proposition. An alternative explanation could be that the effect of sustainability orientation on innovativeness depends on the type of innovation (e.g., product, process, business model). Although previous research demonstrated that the impact of environmental value creation is not dependent on the type of innovation (Hoogendoorn et al., 2020), it could be different for the triple bottom line of sustainability. We cannot resolve this discourse in our study that includes innovation portfolios with all different types of projects. Future research could delve into the nuanced relationship between sustainability and innovativeness by examining whether the effect varies across different types of innovation (e.g., product, process, business model).

While we propose operationalizing sustainability orientation through strategic, cultural, and structural orientation in IPM, further investigation is required on the enablers of sustainability orientation. Such factors can strengthen or weaken the relationship between sustainability orientation and portfolio outcomes. For example, a more turbulent environment might amplify the effect (Kock and Gemünden, 2016). Other contingencies could be the portfolio's size (Kopmann et al., 2015) or complexity (Teller et al., 2012).

Further, former research found that strategic tensions between a sustainability strategy and a company's competitive strategy have negative connotations, leading to the assumption that tensions might negatively impact sustainability orientation (Hengst et al., 2020). However, research drawing on paradoxical theory proposes that interrelated contradictions (like tensions between sustainability and a competitive strategy) can foster sustainability and benefit a company (Hahn et al., 2014). They argue that paradoxical tensions stimulate creativity and learning if managed correctly and in the right environment. Therefore, IPM is an exciting setting to investigate what effects tensions have on a portfolio's innovativeness and under which conditions.

Chapter 6 Research Study E:
Do sustainability tensions harm or benefit innovation portfolios? A paradoxical perspective

Abstract:

The coexistence of financial objectives and sustainability goals often introduces tensions within organizations. Such tensions, traditionally viewed as disadvantageous, can drive creativity and sustainability or instigate defensiveness and destruction if not managed adeptly. This study delves into context factors of managing tensions arising from sustainability strategies in innovation portfolio management. Drawing on paradox theory and innovation management literature, the study investigates the role of contextual factors in moderating the influence of strategic sustainability tensions on a portfolio's innovativeness. We posit that a firm's entrepreneurial orientation and innovation climate act as key organizational characteristics shaping the positive effects of sustainability tensions on portfolio innovativeness. We test our hypotheses through a multi-informant cross-industry survey of 106 innovation portfolios. Our findings reveal that entrepreneurial orientation and innovation climate positively moderate the relationship between strategic sustainability tensions and portfolio innovativeness. The study contributes to the understanding of managing sustainability tensions. Second, it adds empirical evidence to organizational context factors in paradox theory and, third, contributes to innovation management literature on contextual influences in innovation portfolio management. Decision-makers should recognize and leverage strategic tensions in sustainability, fostering a corporate environment that transforms challenges into opportunities for the company's benefit.

Classification in terms of this dissertation:

- **Tensions:** Paradoxical sustainability tensions
- **Sample:** Multi-informant project portfolio management survey (n= 106 portfolios)
- **Method:** Hierarchical regression

Publication and Conferences:

Bechtel, Jadena; Sabini, Luca; Kock, Alexander (2023): Do sustainability tensions harm or benefit innovation portfolios? A paradoxical perspective. *Under review (R1) in a leading innovation management journal (VHB A).*

Earlier versions were presented at the International Product Development Management Conference 2023, Lecco, Italy, and the British Academy of Management Conference 2023, Brighton, England.

6.1 Introduction

Embracing sustainability is vital for companies in today's complex world, where rising societal pressures and competitive advantage opportunities drive them to integrate sustainability, which pays off for companies (Dangelico et al., 2013; Du et al., 2016). Incorporating sustainability by establishing a sustainability strategy enabled companies to engage in business model innovation (Klein et al., 2021) or improve their new product development performance (Claudy et al., 2016; Du et al., 2016).

However, sustainability aspects can be "rife with tensions over the legitimacy of such activities within the existing profit-seeking or competitive practices of an organization" (Hengst et al., 2020, p. 247). For example, the organization may face the dilemma of maximizing shareholders' value in the short term and investing in measures to tackle social or environmental issues in the long term. Tensions among financial and sustainability objectives have traditionally been considered disadvantageous for the organization, assuming such a situation would negatively impact the business due to the complexity added to decisions (Hahn et al., 2014). Tensions from opposing objectives pervade any organizational setting, and they are "neither good nor bad; they can drive creativity and sustainability or lead to defensiveness and destruction" (Smith and Lewis, 2022, p. 5), depending on how they are managed. Former research investigated how to deal with dual strategies (Hengst et al., 2020), but the aftermath of managing tensions from those strategies might be unclear. Especially for a sustainability strategy, organizations do not only strive for a competitive advantage but other non-financial goals (Gatignon and Xuereb, 1997). This novel targeting approach can potentially disrupt decision-making and adversely affect corporate entities. Ongoing discussions remain if tensions in sustainability lead to advantageous outcomes.

Research investigated different managing strategies for opposing tensions that differentiate between accepting those tensions or trying to resolve them (Smith and Lewis, 2011; Hahn et al., 2015). Further, research identified contextual and human factors that enable stakeholders to handle tensions properly and select the right managing strategy (Lewis and Smith, 2022). We know from team research that a paradoxical mindset (human factor) can act as a positive trigger to manage tensions properly and lead to higher innovation performance of the team (Miron-Spektor et al., 2011). However, the predominant dependence on case studies for contextual factors is challenging, especially in sustainability studies (Andriopoulos and Lewis, 2009; Carmine and De Marchi, 2022). Hahn et al. (2017, p. 239f.) argue that "we need a better understanding of the antecedents and boundary conditions of paradoxical responses to sustainability concerns." Therefore, which organizational structures build the boundaries to enable managing strategies in sustainability research remains unclear.

Opposing tensions could lead to, for example, innovative outcomes. Paradox research informs us that competing activities such as exploration and exploitation, which lead to tensions, also have innovation performance advantages (March, 1991; Tushman and O'Reilly, 1996). Smith (2014) explores that

dynamic decision-making for strategic paradoxes is essential for innovations. In a sustainability context, Hahn et al. (2015, p. 309) explain that "structural and technological innovations are not based on a dominant design yet." Therefore, decision-makers should be able to adapt their managing strategies to facilitate the iterative testing of multiple products. The firm's innovation portfolio is ideally suited to examine contextual factors for dynamic decision-making of paradoxical strategies. Indeed, a firm's innovation portfolio management is the decision-making process where tensions between sustainability and competitive strategy become salient. Here, decision-makers select innovation projects to achieve an innovation portfolio that is maximized in value, strategically aligned, and well-balanced (Kester et al., 2011; Martinsuo and Killen, 2014). Thus, decision-makers may observe and experience tensions between sustainability and competitive goals in managing innovation portfolios. These same tensions can be an opportunity to increase a portfolio's innovativeness if managers approach them paradoxically. We ask: *How do contextual factors moderate the influence of sustainable strategic tensions on portfolio innovativeness?*

We argue that companies adopting a specific strategic orientation and supporting norms and values are better equipped to approach strategic tensions paradoxically. Specifically, we identify the company's entrepreneurial orientation and innovation climate as organizational characteristics that leverage the positive effect of sustainability tensions on a portfolio's innovativeness. Following the attention-based view, prior research has highlighted these two contextual factors exerting influence on decision-making in innovation portfolios by redirecting decision-makers' attention (Kock and Gemünden, 2020; Kaufmann et al., 2021).

We test our hypotheses using a multi-informant cross-industry survey of 106 innovation portfolios. At first, the results demonstrate no direct relationship between strategic tensions and a portfolio's innovativeness. Looking at moderating influences of organizational characteristics, we find that entrepreneurial orientation and innovation climate positively moderate the relationship between tensions and innovativeness.

Our study contributes to the research on managing sustainability and how sustainability tensions can be advantageous, leading to more innovative projects (Hahn et al., 2015; Hengst et al., 2020). This research augments prior studies recognizing positive outcomes from incorporating sustainability in innovation management (Claudy et al., 2016; Juntunen et al., 2018; Klein et al., 2021). Further, we add empirical evidence to organizational context factors in paradox theory (Hahn et al., 2017; Carmine and De Marchi, 2022; Lewis and Smith, 2022). Lastly, we contribute to innovation management literature on context factors in innovation portfolio management that influence a portfolio's innovativeness (Kock and Gemünden, 2016; Kaufmann et al., 2021; Globocnik et al., 2022). We recommend that decision-makers clearly identify and acknowledge strategic tensions in sustainability and ultimately create a corporate environment that leverages these tensions to benefit the company (Hahn et al., 2015).

6.2 Theoretical Framework

6.2.1 Tensions and Paradox Theory

Innovations arise if companies can perform explorative and exploitative activities (Tushman and O'Reilly, 1996). Those activities often require different conflicting management approaches, creating tensions that firms must deal with (March, 1991). Tensions in innovation emanate from various sources relating to the fundamental challenge of firms to concurrently augment their knowledge base while optimizing the utilization of pre-existing knowledge resources (Tschang, 2007; Gebert et al., 2010). Other tensions may arise, for example, in open innovation between controlling a firm's knowledge and being open to share this knowledge (Lauritzen and Karafyllia, 2019). Scholarly attention has focused on managing these tensions (i.e., to achieve ambidexterity) as they enable firms to simultaneously create radical and incremental innovations (Andriopoulos et al., 2017). But, elucidating the rationale behind how organizations embrace and manage opposing tensions across diverse organizational levels for innovation, scholars have increasingly turned to the insights provided by paradox theory (Smith and Lewis, 2011).

Indeed, studies adopting the paradox theory have exploded in the last 20 years (Schad et al., 2016). Paradox theory "presumes that tensions are integral to complex systems and that sustainability depends on attending to contradictory yet interwoven demands simultaneously" (Smith and Lewis, 2011, p. 397). With their prominent work, Smith and Lewis primarily wanted to convey two things: first, that organizations constantly face tensions in today's complex world. Second, it is essential to address these tensions simultaneously to be successful (Lewis and Smith, 2022). Paradoxical or opposing tensions are "cognitively or socially constructed polarities that mask the simultaneity of conflicting truths" (Lewis, 2000, p. 761). Besides contradictory tensions, an organization can face dilemmas or dialects. In the following, we direct our attention to the term "paradoxical or opposing tension," as it holds preeminence in paradox theory research (Putnam et al., 2016) and, notably, in the domain of sustainability tensions research, as will be demonstrated in the subsequent section.

Besides research on those opposing situations' presence, scholars are interested in responding to and managing them as they can benefit organizations (Miron-Spektor et al., 2011). In their literature review, Putnam et al. (2016) differentiate between three managing approaches: either-or, both-and, and more-than. Either-or approaches entail consequences for employees and organizations, as they do not address tensions concurrently, instead favoring one side over the other. The both-and approach was strongly shaped by the seminal work of Smith and Lewis (2011). Here, managers and employees do not prefer one opposite pole of the tension to the other but keep and manage both poles simultaneously. More-than approaches are less well-known than the other two managing approaches and "employ

performative practices to engage tensions and avoid premature closure of options" (Putnam et al., 2016, p. 66).

In recent works, Smith and Lewis (2022) introduced a paradoxical framework to navigate tensions. This framework categorizes the existing literature into two overarching dimensions: "people" and "context." Within the "people" dimension, the subcategories include "assumptions" and "comfort," while the "context" dimension encompasses "boundaries" and "dynamics." The "people" dimension summarizes the literature on cognitive mechanisms that trigger managing paradoxical tensions. For example, at an individual level, it has been established that a paradoxical mindset allows employees to deal positively with tensions (Miron-Spektor et al. (2018). Further, the emotions of individuals allow tensions to become recognizable and affect the handling of contradictory tensions (Pradies, 2023). The dimension referred to as "context" unfolds at the organizational level, diverging markedly from the "people" dimension situated at the individual level. Here, the choice of the pursued managing strategy by employees or managers is contingent upon their specific organizational environment (Lewis and Smith, 2022). "Boundaries" are structures and guardrails in a corporate setting that allow individuals to manage paradoxes. Boundaries can be organizational structures enabling separation or integration of opposing tensions, which is, for example, used for organizational ambidexterity (Andriopoulos and Lewis, 2009). "Dynamics" describe "actions that enable change and encourage ongoing shifts between competing demands of paradox" (Smith and Lewis, 2022, p. 86). In conclusion, different managing strategies have been researched sufficiently (Putnam et al., 2016). However, the efficacy of contextual factors in managing paradoxical tensions is contingent upon the specific nature of these tensions (Jules and Good, 2014). Subsequently, we introduce the type of tensions we will investigate.

6.2.2 Paradoxical Tensions in Sustainability

The paradox lens is a favorable theory for sustainability issues because organizations face multiple contradictions between sustainability objectives. Hahn et al. (2017, p. 237) define the paradox perspective for an organization's sustainability issues as follows: "A paradox perspective on corporate sustainability accommodates interrelated yet conflicting economic, environmental, and social concerns to achieve superior business contributions to sustainable development." These conflicts can appear at different organizational levels and in other company areas. The nature of tensions around sustainability objectives is profound, questioning the underpinning ethos of the organizations (Van der Byl and Slawinski, 2015). For example, managers and decision-makers face tensions as long-term versus short-term goals (Carollo and Guerci, 2017; Etzion et al., 2017), contradictions that emerge when dealing with opposing stakeholder interests (Cuganesan and Floris, 2020), or competition over scarce resources (Iivonen, 2017).

Further, tensions arise in a company's competitive strategy when introducing a sustainability strategy. Hengst et al. (2020) identify three types of tensions that arise with the introduction of sustainability

strategy alongside the competitive strategy: tensions between product features, strategic goals, and organizational values. The paradoxical lens helps us understand how both strategies can coexist and how companies can embrace these opposites.

Hahn et al. (2017) define the research on responses to paradoxical tensions in sustainability as descriptive aspects of the paradox perspective. They further mention that literature on descriptive aspects is still scarce. This perspective holds in more recent literature reviews (Carmine and De Marchi, 2022). Hahn et al. (2015) suggest two categories of managing strategies for sustainability tensions. In doing so, they are guided by the managing recommendations of Smith and Lewis (2011).

On the one hand, they recommend acceptance strategies, in which managers do not try to resolve the paradoxes but spontaneously adapt to address the paradoxical tensions. Similar to the both/and approach, organizations can reap benefits. Opposingly, they further suggest two resolution strategies, namely synthesis and separation. Here, managers try to transform the tensions "into a more manageable situation" (Hahn et al., 2015, p. 300). Examples of separation strategies encompass structural solutions akin to those expounded in structural ambidexterity (Hansen et al., 2018), whereby separate organizational units address distinct opposing facets of inherent tensions. Conversely, synthesis strategies manifest as managers aim to bridge opposing tensions. How to manage tensions depends on the area where the tensions occur and on the type of tensions, which is why research on managing tensions relies on case studies (see Carmine and De Marchi (2022). In many instances, research employs case studies, discerning the explicit strategies in use and evaluating their efficacy (van Bommel, 2018; Chen et al., 2021; Schrage and Rasche, 2021).

For the strategic tensions, Hengst et al. (2020) proposed three action cycles of combining, prioritizing, and mutually adjusting for the three strategic tensions (i.e., between product features, goals, and values). It remains unclear how companies can create an organizational context to bring about and support these action cycles. Studies of paradoxes in sustainability frequently overlook the contextual factors and circumstances that facilitate the adoption of the different strategies. On a conceptual level, there are already approaches to contextual factors to manage paradoxical tensions in sustainability, such as the influence factor of organizational agility (Ivory and Brooks, 2017). As we know from the general paradox literature, contextual factors are essential to navigating the paradox (Lewis and Smith, 2022). However, these contextual factors that lead individuals, teams, and organizations to embrace paradoxical decisions remain little explored in sustainability research.

6.2.3 Innovation Portfolio Management and its Context

Innovation portfolio management (IPM) is a decision-making process of selecting, prioritizing, and allocating resources to innovation projects to retain a competitive advantage in dynamic environments (Cooper et al., 1999; Kester et al., 2011). Its primary objective is to maximize the innovation portfolio's

value through a well-balanced and strategically aligned set of projects (Martinsuo and Killen, 2014; Kock and Gemünden, 2020). The innovation portfolio is the essential vehicle for strategy implementation because it connects strategy and operational projects and, thus, largely determines a company's future business (Meskendahl, 2010; Kopmann et al., 2017; Clegg et al., 2018). Precisely in this process, strategic tensions become salient because decision-makers experience tension in the choice between different project alternatives, such as short vs. long-term returns and economic vs financial performances.

Kaufmann et al. (2021) argue that the strategic and cultural context in IPM shapes decision-makers' attention. The authors see a firm's strategic orientation (here, entrepreneurial orientation) as an essential strategic contextual factor because it provides top-down guidance for IPM decision-makers on allocating their attention. In addition, an organization's innovation climate represents a significant cultural contextual factor because it shapes IPM actors' attention bottom-up. Several studies on IPM empirically support the importance of strategic orientation (Salomo et al., 2008; Meskendahl, 2010; Kock and Gemünden, 2020; Kaufmann et al., 2021) and innovation climate (Kock et al., 2015; Kock and Gemünden, 2016; Kaufmann et al., 2021).

We conceptualize the two context factors from IPM research as representative contextual factors that reflect boundaries and dynamics from the conceptual framework by Smith and Lewis (2022) for managing strategic tensions in sustainability. Entrepreneurial orientation is an exemplary factor for the boundaries dimension, as it is a guardrail that enables decision-makers to support complex thinking in their organization. Further, the innovation climate fosters an environment where creativity thrives and novel solutions emerge. Therefore, it can advance the dynamics in an innovation portfolio of all stakeholders to deal with complex situations like sustainability tensions. In this research, we, therefore, concentrate on entrepreneurial orientation and innovation climate as two important organizational characteristics that enable decision-makers to manage sustainability tensions.

Entrepreneurial Orientation. Miller (1983, p. 771) characterizes a firm with entrepreneurial activity as "one that engages in product-market innovation, undertakes somewhat risky ventures, and is first to come up with 'proactive' innovations, beating competitors to the punch." With this definition, he laid the foundation of the three features of an entrepreneurially oriented company: *innovativeness, proactiveness, and risk-taking*. Covin and Slevin (1989) further clarified the three dimensions and developed a concept that describes a company's strategic posture, reflecting these three dimensions. To date, this conceptualization is dominant in entrepreneurship and innovation research. Innovativeness means firms favor innovation while regularly questioning their current business models and products. Proactiveness describes a firm's willingness to obtain a first-mover position by proactively seeking new trends and information in the market (Zhou et al., 2005). Therefore, proactiveness is a strong driver for innovativeness in new product development (Talke et al., 2011). Lastly, risk-taking behavior designates

firms that are not afraid to make bold moves, engaging risks when identifying an opportunity to gain a possible competitive advantage (Lumpkin and Dess, 1996). Entrepreneurial orientation is not only a critical antecedent to firm performance, as confirmed by meta-analyses (Rauch et al., 2009; Rosenbusch et al., 2011). Several studies have also shown that it is a relevant contingency factor in innovation portfolio decision-making (Kock and Gemünden, 2020; Kaufmann et al., 2021).

Innovation climate. Innovation climate refers to the support, autonomy, and creative feedback the management gives its employees, encouraging them to pursue innovative tasks. The innovative climate in the company plays an essential role in developing creative ideas (Scott and Bruce, 1994). According to Amabile et al. (1996), employees are more creative in an environment emphasizing freedom and autonomy and providing sufficient resources. Further, managers should encourage and value employee idea generation. Consequently, employees can develop ideas freely and are motivated to contribute to them without reprimanding. This is accompanied by employees feeling safe to express and discuss their thoughts even if not everyone in the team shares the same view (Anderson and West, 1998). Previous research showed that innovation climate is essential in IPM decision-making (Kock and Gemünden, 2020; Kaufmann et al., 2021).

6.3 Hypotheses

We present our conceptual framework in Figure 9. First, we hypothesize that a firm's entrepreneurial orientation as strategic posture positively moderates the relationship between sustainability tensions and a portfolio's innovativeness. Second, we hypothesize that innovation climate is a positive moderator for the effect of sustainability tensions on portfolio innovativeness.

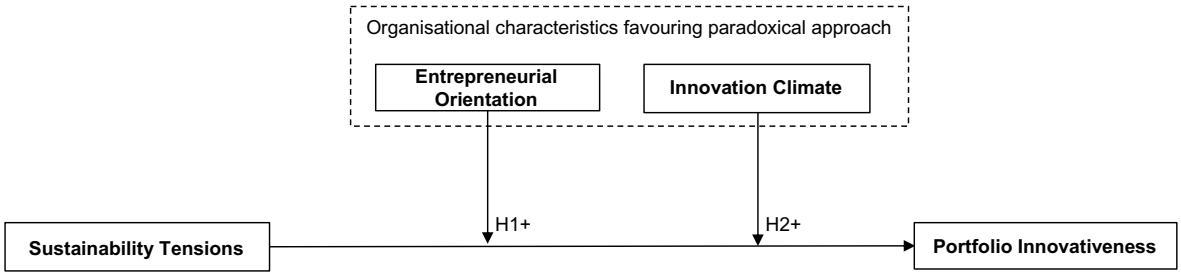

Figure 9. Conceptual Framework. (Research Study E)

6.3.1 Entrepreneurial Orientation as Boundary toward Managing Sustainability Tensions

We hypothesize that a firm's entrepreneurial orientation strengthens the positive relationship between sustainability tensions and portfolio innovativeness. Here, entrepreneurial-oriented firms possess skills to help IPM deal with paradoxical problems.

Prior literature emphasized that entrepreneurial orientation allows decision-makers to shift their attention toward more innovative options, thus identifying it as a contextual factor with a positive influence on the innovativeness of an innovation portfolio (Kaufmann et al., 2021). Further, such a strategic posture led firms to identify sustainability issues as opportunities and be more committed to sustainability (Jansson et al., 2017). We argue that highly entrepreneurial-oriented firms can manage sustainability tensions to their advantage. We will exemplify our reasons in the following.

The entrepreneurial orientation supports innovation portfolios embracing a dynamic equilibrium. Smith and Lewis (2011, p. 393) stated that promoting "creativity and learning" while fostering "flexibility and resilience" enables firms to manage paradoxical tensions. Firms that address economic and environmental/social goals take "a high risk of unintended consequences because a solution to one issue could be detrimental to that of another" (Hahn et al., 2015, p. 298). Here, a firm's high entrepreneurial orientation encourages risk-taking. The innovation portfolio stakeholders are accustomed to taking risks and aggressively exploiting potential opportunities. Therefore, firms with a high entrepreneurial orientation accept the risks from strategic tensions and let decision-makers embrace these risks, which could then lead to more innovative products.

Second, organizations with proactive and innovative entrepreneurial behavior are used to introducing new products and technologies frequently. Klein et al. (2021) argue that besides entrepreneurial orientation driving business model innovation, it enables firms to search for innovative solutions to solve sustainability issues actively. These companies prefer to take the initiative. Hence, they sense their environment and identify opportunities and needed changes early (Kock and Gemünden, 2020). These capabilities support IPM in making sustainability tensions salient and transparent within the innovation portfolio. Furthermore, companies with a pronounced proactive orientation can react flexibly to tensions, a fundamental characteristic of managing tensions (Smith and Lewis, 2011).

In summary, entrepreneurial-oriented firms enable decision-makers to accept and manage sustainability tensions, leading to more innovative projects. Thus, we posit:

H1: Entrepreneurial orientation positively moderates the relationship between strategic sustainability tensions and portfolio innovativeness.

6.3.2 Innovation Climate Fostering Dynamics toward Managing Sustainability Tensions

An innovation climate is necessary to integrate employees into the innovation process. We expect the innovation climate to positively moderate sustainability tensions' relationship with portfolio innovativeness for two reasons.

Empirical studies demonstrated that innovation climate improves decision-making quality in innovation portfolios (Kock and Gemünden, 2016), product quality in resource-constrained innovation projects (Weiss et al., 2011), the front-end innovation performance (Bertels et al., 2011; Kock et al., 2015), and a portfolio's innovativeness (Kaufmann et al., 2021).

Tensions in sustainability can cause discussions within the portfolio. Hahn et al. (2015, p. 303) state that "[a] manager who nonetheless pursues sustainability objectives that deviate from the organisational agenda thus risks facing disapproval by the organisation." In an innovation portfolio, project managers, portfolio coordinators, or decision-makers are managers on different hierarchy levels. Each of them may experience tensions that may meet disagreement by the other stakeholders in the portfolio. In a strong culture of innovation, all views are equally valuable, and managers do not have to hide this conflict. Still, they can address it openly, which makes sustainability tensions salient and helps manage them. In dynamic equilibrium, "the role of leadership is to support opposing forces and harness the constant tension between them, enabling the system to not only survive but continuously improve" (Smith and Lewis, 2011, p. 386). Leaders' behavior indicates the innovation climate (Amabile et al., 1996). First, leadership behavior can help lower-level managers make paradoxical tensions salient by shaping their context (Knight and Paroutis, 2016). Second, discussions are not detrimental in a culture that supports debates and openness. Hahn et al. (2015, p. 305) argue that acceptance strategies foster "creative tensions," which can lead to innovation. Here, companies understand and embrace different views.

Further, sustainability tensions can lead to constraints in the innovation portfolio. For example, conflicting product features between sustainable and competitive characteristics lead to prioritizing or compromising certain features. In this case, a sustainability strategy can lead to constraints (Hengst et al., 2020). Weiss et al. (2011, p. 200) found that an innovation climate enabled the innovation team to manage financial resource constraints better and ultimately improve product quality. They argue that team innovation climate overcomes "barriers of capability" to innovatively develop new approaches to work around capacity scarcity and "barriers of will" through supportive and open-minded employees who are willing to take risks (Weiss et al., 2011, p. 200). Thus, we argue that constraints stemming from sustainability tensions can lead to innovative outcomes when combined with an innovation climate that supports a psychologically safe environment where employees can openly exchange ideas and develop new ones.

In conclusion, discussions and constraints triggered by tensions can help generate innovative ideas under the right circumstances. We argue that an innovation climate positively moderates the influence between tensions and innovativeness. We formulate our second hypothesis as follows:

H2: Innovation climate positively moderates the relationship between strategic sustainability tensions and portfolio innovativeness.

6.4 Methodology

6.4.1 Sample

We use a cross-industry sample of innovation portfolios (unit of analysis) to test our hypotheses. We contacted 500 organizations with portfolios of at least 20 simultaneously running projects. We targeted three types of informants per portfolio that answered our survey. First is a decision-maker (e.g., C-level manager, head of R&D, or division head) with decision-making authority to select and terminate the innovation portfolio's projects. The second is a portfolio coordinator responsible for managing the innovation portfolio with a good overview of the portfolio processes. Typical job titles of the coordinator were innovation manager, head of PMO, or senior manager. Third, we surveyed multiple project managers leading some of the innovation portfolio's projects. The multi-informant design reduces possible common method bias (Podsakoff et al., 2003) as the coordinator assesses the endogenous variable and the senior manager and project managers assess the exogenous variables. Our response rate was 25 percent. However, we could only use portfolios with answers from all informants as they assessed the different variables in our model. We had answers from 125 innovation portfolios, but six portfolios only had decision-maker responses, and 13 portfolios only had coordinator responses. Therefore, the final sample comprises 552 responses from 106 innovation portfolios with an average of 5.2 respondents per portfolio (106 decision-makers, 106 portfolio managers, and 340 project managers). We provide other sample characteristics in Table 15 (i.e., distribution of industry, employees, portfolio budget, and revenue).

Table 15. Sample Characteristics. (Research Study E)

Industry		Employees	
Mechanical and vehicle engineering	12.26 %	<500	24.53 %
Electrician/ Electronics technician/ ICT	14.15 %	500-2000	24.53 %
Banks/ Insurances	23.58 %	>2000	50.94 %
Traffic/ Transport/ Logistics/ Construction	7.55 %		
Chemistry/ Pharma	6.60 %		
Healthcare	5.66 %		
Other	30.20 %		
Revenue		**Portfolio Budget**	
<100 mil. EUR	18.87 %	<10 mil. EUR	16.04 %
100-500 mil. EUR	20.75 %	10-30 mil. EUR	22.64 %
501-2000 mil. EUR	10.38 %	30-100 mil. EUR	26.41 %
>2000 mil. EUR	50.00 %	>100 mil. EUR	34.91 %

6.4.2 Measurement

We used multi-item measurement scales to assess the variables. We derived the constructs from the literature except for sustainability tensions. Here, we designed our items following Hengst et al.'s (2020) qualitative concept of strategic tensions. If not otherwise stated, we used seven-point Likert scales ranging from 1 ("strongly disagree") to 7 ("strongly agree"). We applied confirmatory factor analysis (CFA) to evaluate the scales' validity. We measured Cronbach's Alpha, the average variance extracted, and composite reliability for scale reliability (Ahire and Devaraj, 2001). We used several measures from Chan (1998) and Podsakoff et al. (2003) to reduce common method bias. Most importantly, we used different informants for the independent and dependent variables. Table 17 and Table 18 list all items' wordings and the CFA results (which include reliability scores and the item's loadings).

Dependent variable: Portfolio innovativeness is an established measure from former literature, which we slightly adapted to our context (Talke et al., 2011; Schultz et al., 2013; Kaufmann et al., 2021). We operationalized portfolio innovativeness as a second-order construct that consists of two dimensions. Market innovativeness ($\alpha = 0.798$) describes how new the product or project results are to the market. Technological innovativeness ($\alpha = 0.872$) describes how new the technologies are the organization uses in their products or projects. The portfolio coordinator assessed this variable.

Independent variable: We operationalized *strategic sustainability tensions* with three items following the developed theoretical framework from Hengst et al. (2020). Here, they differentiate tensions between a competitive strategy and a sustainability strategy into three dimensions: tensions between product features, tensions between values, and tensions between goals. We adapted those dimensions to the innovation portfolio setting but maintained the basic ideas behind those dimensions. Instead of tensions between product features, we asked for tensions between attributes of the portfolio's projects. For values and goals, we could stick to the wording described in the theory developed by Hengst et al. (2020). Portfolio decision-makers assessed the variable ($\alpha = 0.768$).

Moderators: We measured *entrepreneurial orientation* by taking the widely used scale from Covin and Slevin (1989), which consists of three dimensions: innovativeness, proactiveness, and risk-taking. For each dimension of entrepreneurial orientation, we used three items for assessment. Overall, we aggregated the nine items into one second-order construct. Decision-makers assessed the entrepreneurial orientation of the organization as the construct relates to the overall strategic composition of the firm. The second moderator, *innovation climate*, consists of four items and describes how the organization encourages employees to creative thinking and open debates (Kock and Gemünden, 2016; Kaufmann et al., 2021). To assess the climate, we averaged the answers from project managers and the portfolio coordinator because the climate directly addresses lower-hierarchy

employees' openness and psychological safety ($\alpha = 0.873$). By integrating responses from project managers, we strived for a more objective assessment.

Control variables: We considered several control variables as they might influence the independent or dependent variable. We included the natural logarithm of the annual *portfolio budget* in a million Euros as more budget enables companies to invest in more R&D expenditures and might influence the innovativeness of the portfolio. Further, we included the portfolio management *formalization* ($\alpha = 0.888$) as a four-item construct by Teller et al. (2012). Formalized portfolios might have fewer sustainability tensions as they are more mature in their processes and already integrated sustainability holistically. Portfolio coordinators assessed the variable. *Stakeholder pressure* describes how much pressure different sources are exerting on the company to implement the topic of sustainability. We took the measurement from Wijethilake and Lama (2019) and adapted it slightly to our context. We asked how much pressure the following sources exert on their company to implement sustainability: customers and society, government and regulatory bodies, shareholders, and competitors. Stakeholder pressure is a composite formative construct due to multiple reasons fulfilling the definitional criteria by Jarvis et al. (2003). A change in one of the items does not directly indicate a change in another item but still influences the overall value of the construct. Further, the items can have different antecedents and outcomes. For example, exerting competitors' pressure on the company does not directly mean that the pressure from governmental bodies will increase. Also, pressure from competitors possibly has other motivations (antecedents) than one of the regulatory bodies. Lastly, by excluding an item, we would change the meaning of the construct as the construct comprehensively maps an organization's stakeholders for the topic of sustainability (Wijethilake and Lama, 2019). We controlled for *technology and market turbulence* by taking the established measurement from Sethi and Iqbal (2008). Technology turbulence ($\alpha = 0.806$) and market turbulence ($\alpha = 0.763$) each consist of three items describing the changes in the industry regarding technology and the market, respectively. We wanted to differentiate between stakeholder pressure and an overall turbulent environment as we argued our hypothesis specifically on pressure, not just a turbulent environment. Further, companies in turbulent environments tend to innovate to maintain a competitive advantage. Decision-makers assessed the variable. Additionally, we controlled for the *strategic control* ($\alpha = 0.922$) of projects, which describes the extent to which portfolio management reviews the fit between projects and a portfolio's strategy while at the same time regularly questioning the strategy. We used three items from former literature, and portfolio coordinators assessed the variable (Kopmann et al., 2015; Bechtel et al., 2022). Strategic control might influence the strategic sustainability tensions as portfolios with pronounced strategic control might be more aware of tensions but might also be better at coping with them. Decision-makers assessed the variable. We present the correlations and statistics in Table 16.

Table 16. Descriptives and Correlations. (Research Study E)

Variables	M	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Portfolio budget	3.75	1.78									
(2) Formalization	4.83	1.73	.17								
(3) Technology turbulence	4.99	1.14	-.04	.22							
(4) Market turbulence	3.71	1.15	-.21	-.01	.54						
(5) Strategic control	3.47	1.55	.05	.44	.04	-.11					
(6) Portfolio innovativeness	3.89	1.11	.15	-.04	.27	.33	.11				
(7) Sustainability tensions	3.96	1.2	-.02	-.16	-.01	.10	-.06	.18			
(8) Entrepreneurial orientation	3.98	0.89	.14	.02	.44	.38	-.07	.30	.12		
(9) Innovation climate	5.02	0.83	.10	.27	.19	.23	.25	.32	.11	.29	
(10) Stakeholder pressure	4.87	0.89	.28	.28	.13	.09	.06	.20	.08	.16	.23

Table 17. Survey Items - Hypotheses variables (Research Study E)

Construct	Informant	Items	lambda
Sustainability tensions	Decision-maker	We experience tensions in prioritization between sustainability values and the economic values of the competitive strategy.	.61
($Alpha = 0.768$; $AVE = 0.542$; $CR = 0.777$)		The economic and sustainable attributes of our project results are at odds with each other.	.74
		We experience tensions between the strategic goals of the competitive strategy while simultaneously adhering to goals of the sustainability strategy.	.85
Portfolio innovativeness (2nd order construct)			
Market innovativeness	Coordinator	Our products/ project results ...	.88
($Alpha = 0.798$; $AVE = 0.550$; $CR = 0.785$)		... offer new customer benefits which were not previously provided by any other products.	.66
		... create a completely new market.	.74
		... completely change the way our market functions.	.81
Technological innovativeness	Coordinator	Our products/ project results ...	.69
($Alpha = 0.872$; $AVE = 0.672$; $CR = 0.860$)		... are based on new technological principles.	.74
		... use new technologies that make older technologies obsolete.	.85
		... use technologies that enable leaps in performance.	86
Entrepreneurial orientation (2nd order construct)			
Innovativeness	Decision-maker	In general, the top managers of my business unit favor …	.76
($Alpha = 0.769$; $AVE = 0.521$; $CR = 0.764$)		… a strong emphasis on the marketing of tried and true products or services. -- … a strong emphasis on R&D, technological leadership, and innovations.	.82
		How many new lines of products or services has your business unit marketed during the past three years?	.68
		No new lines of products or services. -- Many new lines of products or services.	
		Changes in product or service lines have been mostly of a minor nature. -- Changes in product or service lines have usually been quite dramatic.	.65

Risk-taking	Decision-maker	In general, the top managers of my business unit have …	.83
($Alpha = 0.783$; $AVE = 0.517$; $CR = 0.762$)		… a strong proclivity for low risk projects (with predictable and moderate rates of return). -- … a strong proclivity for high risk projects (with chances for very high returns).	.75
		Due to the nature of the environment…	.65
		… it is best to explore it gradually via cautious, incremental behavior. -- … bold, wide-ranging acts are necessary to achieve the firm's objectives.	
		When confronted with decision-making situations involving uncertainty, my business unit …	.75
		… typically adopts a cautious "wait-and-see" posture in order to minimize the probability of making costly decisions. -- … typically adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.	
Proactiveness	Decision-maker	In dealing with its competitors, my business unit …	.86
($Alpha = 0.698$; $AVE = 0.442$; $CR = 0.694$)		… typically responds to actions which competitors initiate. -- … typically initiates actions to which competitors respond.	.69
		… is seldom the first business to introduce new products/ services, administrative techniques, operating technologies, etc. -- … is very often the first business to introduce new products/ services, administrative techniques, operating technologies, etc.	.80
		… typically seeks to avoid competitive clashes, preferring a "live-and-let-live" posture. -- … typically adopts a very competitive "undo-the-competitors" posture.	.46
Innovation climate	Coordinator and project managers	In our organization, …	
($Alpha = 0.873$; $AVE = 0.654$; $CR = 0.883$)		… employees are given sufficient responsibility, resources, and freedom to work independently.	.74
		… communication is open, meaning that we share information and appreciate debates and diverse opinions.	.76
		… we emphasize creativity and innovativeness.	.89
		… supervisors encourage unconventional ideas.	.84

Note: Model fit $\chi 2[198] = 265.880$; comparative fit index [CFI] = 0.928; root mean square error of approximation [RMSEA] = 0.057; standardized root mean square residual [SRMR] = 0.075. Abbreviations: AVE, average variance extracted; CR, composite reliability.

Table 18. Survey Items - Control Variables (Research Study E)

Construct	Informant	Items	lambda
Technology turbulence ($Alpha = 0.806$; $AVE = 0.567$; $CR = 0.796$)	Decision-maker	The technology used in our industry is changing rapidly.	.82
		There are frequent technological breakthroughs in our industry.	.76
		Technological changes provide big opportunities in our industry.	.67
Market turbulence ($Alpha = 0.763$; $AVE = 0.529$; $CR = 0.769$)	Decision-maker	In our industry customer preferences change relatively quickly.	.75
		In our industry it is difficult to predict how customers' needs and requirements will evolve.	.79
		In our industry it is difficult to forecast competitive actions.	.63
Strategic Control ($Alpha = 0.922$; $AVE = 0.812$; $CR = 0.928$)	Coordinator	We regularly review the feasibility of the portfolio strategy based on the information obtained in projects.	.85
		We regularly review the premises of strategic portfolio planning based on new developments in the projects.	.95
		Based on the information gained in projects, we deliberately question the portfolio strategy.	.90
Formalization ($Alpha = 0.923$; $AVE = 0.768$; $CR = 0.930$)	Coordinator	Essential project decisions are made within clearly defined portfolio meetings.	.78
		Our project portfolio management process is divided in clearly defined phases.	.89
		Our process for project portfolio management is clearly specified.	.94
		Overall, we execute our project portfolio management process in a well-structured manner.	.89

Note: Model fit $\chi 2[59] = 125.38$; comparative fit index [CFI] = 0.927; root mean square error of approximation [RMSEA] = 0.104; standardized root mean square residual [SRMR] = 0.066. Abbreviations: AVE, average variance extracted; CR, composite reliability.

6.5 Results

We test our hypotheses using hierarchical ordinary least squares (OLS) regression with interaction effects. Table 19 presents the analysis and results. Model 1 shows the effects of the control variables on portfolio innovativeness. We can see that portfolio budget ($b = 0.126; p = .036$), formalization ($b = -0.150; p = .028$), market turbulence ($b = 0.295; p = .006$), and strategic control ($b = 0.159; p = .027$) are and remain significant throughout the models. Technology turbulence and stakeholder pressure have no significant relationship with innovativeness. Model 2 includes sustainability tensions that do not significantly relate to portfolio innovativeness ($b = 0.113; p = .175$), as we assumed in our theoretical framework. In Model 3, we add the moderating variables and find no direct relationship between entrepreneurial orientation and portfolio innovativeness but between innovation climate and portfolio innovativeness ($b = 0.266; p = .047$). In Model 4, we test the interaction term between sustainability tensions and entrepreneurial orientation on portfolio innovativeness. We find a positive coefficient ($b = 0.218; p = .031$), confirming hypothesis 1. Model 5 shows the interaction effect of

sustainability tensions and innovation climate on innovativeness, which is positive ($b = 0.221; p = .034$). Therefore, we can also confirm hypothesis 2.

To better interpret our results, we plotted sustainability tensions' marginal effects for different levels of innovation climate or entrepreneurial orientation (see Figure 10, left side). Further, we plotted the interaction effects as simple slopes (see Figure 10, right side). The diagrams show the relationship between sustainability tensions and portfolio innovativeness for a low value of the moderator (grey dashed line) and a high value of the moderator (black line). A low (high) value describes the mean of the moderator minus (plus) one standard deviation. Both diagrams show that sustainability tensions are only positively associated with portfolio innovativeness when the moderator is highly pronounced. It suggests that the respective organizational characteristic enables project portfolios to embrace sustainability tensions better and develop innovative solutions in their project portfolio. If the two moderators are low, we see a negative relationship between tensions and portfolio innovativeness.

To rule out other explanations, we tested different alternatives. First, it could also be that the experienced tensions depend on the industry. Some industries already focusing on sustainability concerns (e.g., the energy sector) may not experience the same tensions between their competitive and sustainability strategy. Due to our sample size, incorporating a categorical variable with seven industries (see Table 15) is not feasible. Thus, we included the stakeholder pressure as a proxy for the industry. We further tested with a one-way analysis-of-variance (ANOVA) if there are significant differences between sustainability tensions among industries. The ANOVA was not significant between industries ($p = .930$). Therefore, not integrating industries as a control variable is acceptable.

Second, it could also be that companies with an established sustainability orientation exhibit fewer tensions and, fundamentally, are more innovative as they can react quickly to new circumstances in terms of sustainability (Claudy et al., 2016; Klein et al., 2021). Consequently, we conducted another analysis that included sustainability orientation[4] as a control variable and still found support for both hypotheses. We will discuss our findings in the following section.

[4] Strategic sustainability orientation is a three-item variable answered by decision-makers that incorporates the following items: Sustainability plays an important role in our strategy formulation / We actively try to formulate a sustainable strategy for our company / We regularly review which strategic aspects we can make sustainable in the company.

Table 19. Regression Results. (Research Study E)

	Portfolio innovativeness				
	(1)	(2)	(3)	(4)	(5)
Portfolio budget (ln)	0.13*	0.13*	0.11+	0.11+	0.11+
	[0.04]	[0.03]	[0.08]	[0.07]	[0.06]
Formalization	-0.15*	-0.13+	-0.15*	-0.15*	-0.13+
	[0.03]	[0.05]	[0.03]	[0.03]	[0.06]
Technology turbulence	0.13	0.13	0.11	0.12	0.09
	[0.24]	[0.21]	[0.32]	[0.25]	[0.43]
Market turbulence	0.29**	0.28**	0.21*	0.23*	0.23*
	[0.01]	[0.01]	[0.05]	[0.04]	[0.03]
Strategic control	0.16*	0.16*	0.13+	0.13+	0.12+
	[0.03]	[0.03]	[0.07]	[0.07]	[0.08]
Stakeholder pressure	0.18	0.16	0.13	0.15	0.11
	[0.13]	[0.18]	[0.27]	[0.19]	[0.37]
Sustainability tensions		0.11	0.09	0.06	0.08
		[0.18]	[0.29]	[0.48]	[0.32]
EO			0.10	0.11	0.09
			[0.46]	[0.38]	[0.46]
Innovation climate			0.27*	0.23+	0.23+
			[0.05]	[0.08]	[0.09]
Sustainability tensions x EO				0.22*	
				[0.03]	
Sustainability tensions x Innovation climate					0.22*
					[0.03]
Constant	0.97	1.03	1.08*	1.52*	1.84*
	[0.16]	[0.14]	[0.02]	[0.05]	[0.02]
R-squared	0.23	0.24	0.28	0.32	0.32
Adjusted R-squared	0.18	0.19	0.22	0.25	0.24
F	4.86	4.46	4.20	4.41	4.39

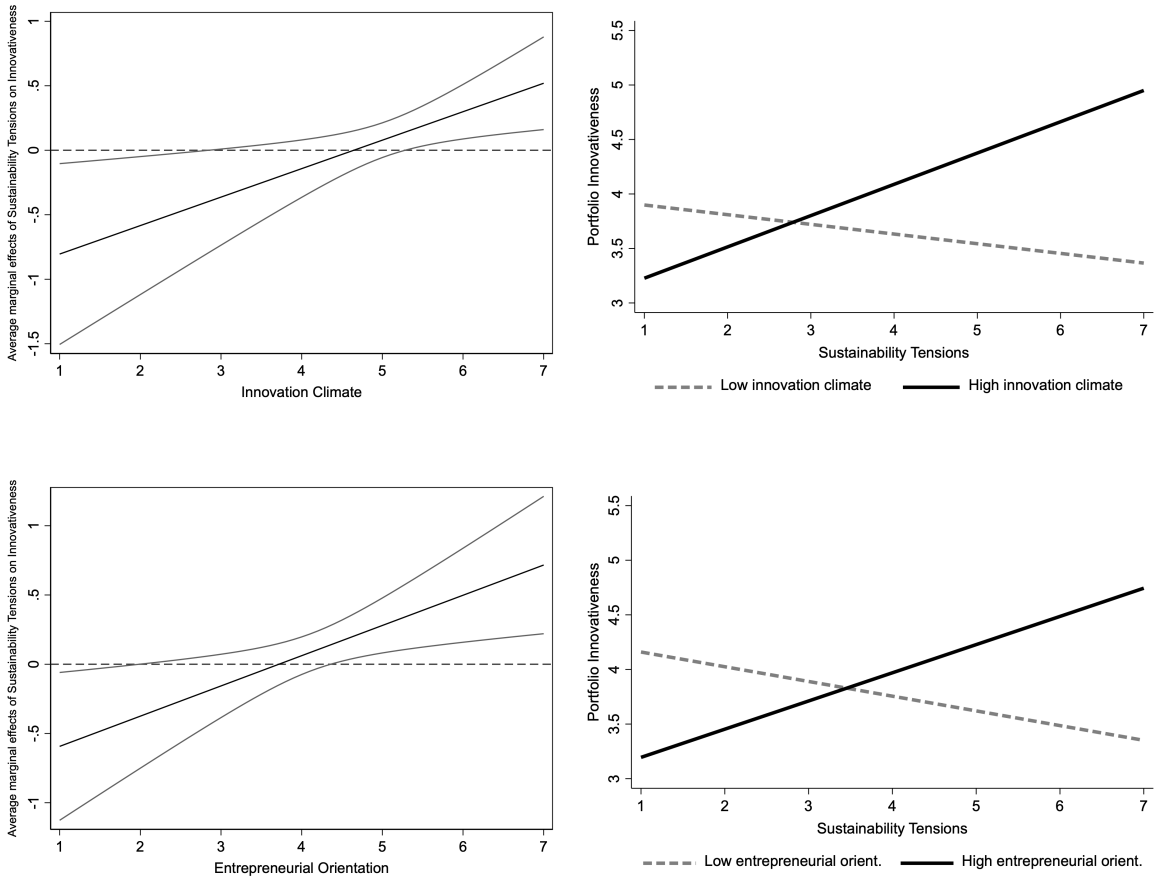

Figure 10. Left side: Marginal effects of sustainability tensions on portfolio innovativeness for different levels of innovation climate or entrepreneurial orientation (grey lines represent 90% confidence bands). Right side: Simple slopes of the relationship between sustainability tensions and portfolio innovativeness with high/low innovation climate or entrepreneurial orientation. (Research Study E)

6.6 Discussion

Firms increasingly introduce sustainability strategies due to rising external pressure and the possibility to innovate, ultimately gaining a competitive advantage (Claudy et al., 2016; Klein et al., 2021). Tensions between the newly introduced sustainability strategy and the established competitive strategy can arise. Hengst et al. (2020) identified three dimensions of contradicting product features, values, and goals. The current study aimed to empirically investigate two organizational context factors (i.e., an organization's entrepreneurial orientation and innovation climate) enabling innovation portfolios to successfully manage sustainability tensions and become more innovative.

6.6.1 Theoretical Implications

With our research, we make three primary contributions to the literature. First, we add to the literature on sustainability tensions and how organizations can use them to their advantage. Sustainability tensions

can occur and be perceived at different levels, like the individual or organizational level. Former research argued that sustainability tensions can also be disadvantageous as decision-makers and employees may face conflicting goals that seem intractable (Hahn et al., 2014). The newly introduced sustainability goals might be incompatible with the competitive goals of a company. These tensions can overwhelm employees and possibly lead to incomprehension (Miron-Spektor et al., 2011). But, "[t]ensions are […] productive because they enable actors to work toward legitimation of both strategies in action, which reinforces their co-enactment at the organizational level" (Hengst et al., 2020, p. 265). Our study provides quantitative support that sustainability tensions can make companies more innovative (Hahn et al., 2017).

Second, we contribute to paradox theory by investigating contextual factors for managing paradoxical tensions (Lewis and Smith, 2022). Former research provided coping strategies for contradictory tensions (Putnam et al., 2016). In engaging paradoxical tensions effectively, tensions can bring positive outcomes to companies like team innovativeness (Gebert et al., 2010), ambidexterity (Andriopoulos and Lewis, 2009), and creativity (Schad et al., 2016), if managed correctly. However, research on contextual factors lacked quantitative evidence, especially in sustainability research, and relied on case studies (Hahn et al., 2017; Carmine and De Marchi, 2022). We follow recent works from Smith and Lewis (2022) and add to the toolbox to navigate the paradox by identifying boundaries and dynamics factors for managing strategic paradoxical tensions.

Lastly, we contribute to the literature on IPM. The findings highlight that entrepreneurial orientation constitutes a moderator in managing strategic tensions. In doing so, we confirm and expand the results from Kaufmann et al. (2021), who found that entrepreneurial orientation can be a contextual factor promoting a portfolio's innovativeness. Therefore, we add to the literature on contextual factors influencing a portfolio's innovativeness (Kock and Gemünden, 2016; Globocnik et al., 2022). We also respond to the call for further research on strategic orientations and strategies regarding sustainability in innovation management (Klein et al., 2021). Former research demonstrated that an orientation toward sustainability positively relates to an organization's NPD success (Claudy et al., 2016) or its innovation activity (Hoogendoorn et al., 2020; Klein et al., 2021). So far, this literature has only considered whether sustainable values are essential for the company. Still, it neglected how these values translate into a strategy and whether they conflict with a competitive strategy. By demonstrating that managing strategic tensions with high levels of entrepreneurial orientation and innovation climate improves a portfolio's innovativeness, we further clarify how a sustainability strategy can be integrated into existing structures. It expands previous findings from a multiple case study by Juntunen et al. (2018) that identified that deep organizational engagement is needed for sustainability strategies to work and benefit companies. Therefore, we add a study on strategic sustainability tensions to the growing topic of sustainability in innovation management (Claudy et al., 2016; Juntunen et al., 2018; Klein et al., 2021).

6.6.2 Managerial Implications

Managers can draw several implications from this study. First, managers should know that tensions must be salient before managing them. Here, an innovation climate can support the constant exchange between portfolio stakeholders to identify emergent tensions. Further, a pronounced innovation climate helps develop ideas for managing the tensions. Therefore, decision-makers and portfolio coordinators should take the necessary steps to strengthen the innovation climate. For example, they can set up a project manager community because some innovation project managers might have no experience with sustainability issues. A project manager community enhances the exchange of experiences among project managers, supporting an open atmosphere because higher hierarchical employees are absent.

However, we want to remind decision-makers that tensions can also harm a portfolio's innovativeness and performance if the identified organizational characteristics (i.e., innovation climate and entrepreneurial orientation) are weak. Here, portfolio stakeholders might not manage tensions correctly, which is detrimental because the tensions might not become salient, and other portfolio stakeholders perceive tensions negatively.

6.6.3 Limitations and Future Research

This study's results come with limitations that need to be considered while interpreting the results but point in several directions for future research. First, our sample consists of European companies. However, cultures in other countries besides Europe might differ in managing paradoxical tensions. Keller et al. (2017) found that differences in paradoxical framing and mindset appear under specific conditions because of different cultures (in their case, Chinese and American cultures). Thus, our results should be interpreted with caution. Future research could investigate if the findings are transferable to other cultural settings and under which conditions.

Second, we focused on tensions between competitive economic and sustainability strategies (Hengst et al., 2020). Therefore, we deliberately omitted further tensions that might arise between ecological and social objectives. Hall and Vredenburg (2003) bring up the example of environmental solutions that are not socially accepted and thus not socially sustainable. An electric car is more environmentally sustainable but comes with a potential social disadvantage, as it is not available to everyone in the population due to its higher prices. Therefore, it would increase social inequality. In sustainability measurements for companies, community service and customer responsibility are part of the social performance pillar (Ioannou and Serafeim, 2012). Thus, two topics would be of interest to future research. First, how innovation portfolios define and integrate social sustainability into their innovation process. In addition, a qualitative study could shed light on dealing with tensions between ecological and social objectives and their effects on a portfolio's innovativeness.

Third, future studies could open the black box on how innovation portfolios manage contradictory tensions and if there are mechanisms that mediate the relationship between sustainability tensions and innovation performance.

Chapter 7 Discussion

My dissertation investigates how projects and project portfolios successfully manage tensions to be innovative and, eventually, successful. In two studies, I focus on agility at the project and portfolio levels. I examine sustainability and its impact on projects and portfolios in three studies. This chapter presents the overarching theoretical and practical implications based on the five studies. Lastly, I provide a perspective for future research opportunities.

7.1 Conclusion

The first research question, focusing on tensions of agile values, research study A examines how the relationship between agile practices and project success is mediated by TWQ while accounting for portfolio-level contingencies. Agile practices support teamwork quality by encouraging regular interactions within the team and preventing discussions with other stakeholders through regular feedback from customers. TWQ, in turn, positively impacts the project's success. However, the positive relationship is weakened if the portfolio follows traditional management practices in selecting and steering projects. Traditional PPM can lead to tensions between agile project teams and portfolio management. More specifically, business case existence, strategic clarity, and operational control could limit agile teams' creativity. In addition, tensions can arise because portfolio management requirements are designed for traditionally managed projects and cannot be applied to agile projects. Agile teams may need to adapt their routines, which can lead to dissatisfaction and debate. Study B examines agility at the portfolio level. In study B, agility is defined more broadly as the ability of the portfolio to adapt to changing conditions. We analyze which antecedents lead to an adaptive project portfolio and success. We find that dynamic capabilities are a relevant antecedent of portfolio agility. Furthermore, portfolio agility mediates the relationship between dynamic capabilities and portfolio success. However, we see a more nuanced result when we test the complementarity of dynamic capabilities. When a portfolio lacks the sensing and reconfiguring dimension of dynamic capabilities, portfolio managers cannot correctly sense portfolio changes, and the project portfolio loses agility. The quick response to shifting resources to more promising projects is then dysfunctional. Thus, the study emphasizes the importance of boundary conditions to successfully implement agility. The primary finding of the first research question is that the conditions necessary for agility must be present at both the project and portfolio levels. This dissertation concludes that project portfolio management can design and adapt their framework conditions, including their processes and dynamic capabilities.

I rely on three studies to answer the second research question and investigate the effects of sustainability tensions. Study C explores the opportunities and barriers of agglomeration effects in urban sustainability

projects (i.e., living labs). Living labs create innovative ideas and foster cooperation on a local level. However, we find that agglomeration effects are not beneficial for every partner simultaneously and could also lead to trade-offs among the collaborating partners. Studies D and E assess the impact of a sustainability orientation at the portfolio level. As there is little quantitative evidence in portfolio research, Study D examines the general introduction of a sustainability orientation and its impact on portfolio innovativeness and, eventually, success. Holistic sustainability orientation encompasses three dimensions: cultural, strategic, and operational. This study shows that organizations with a strong focus on sustainability tend to select more innovative projects within their innovation portfolio and consequently achieve higher levels of success within that portfolio. Decision-makers' awareness shifts toward sustainability topics, fostering the development of innovative technological products or processes. Going sustainable can also open up new, sustainability-oriented markets. In contrast to study D, study E focuses explicitly on sustainability tensions and their relationship to portfolio innovativeness, considering portfolio contingencies. We show that tensions between sustainability and competitive strategies positively relate to portfolio innovativeness in the proper context. A strong innovation climate and entrepreneurial orientation enable project portfolios to embrace and manage these tensions. This does not mean there are no tensions, but the study underlines the importance of contingencies. In conclusion to the second research question, this dissertation demonstrates that tensions arising from sustainability can lead to innovative outcomes at the project and portfolio level, provided that certain conditions are met. It is, therefore, favorable to adopt a holistic approach to sustainability integration and contingencies that embrace paradoxical tensions.

In conclusion, this dissertation emphasizes the importance of agility and sustainability for projects and project portfolios. Tensions can arise in the project portfolio when new practices or strategies are introduced. It is essential to adapt the portfolio or projects to the unique circumstances. Portfolio managers and decision-makers are responsible for creating the proper context for employees so that change is not perceived as an obstacle but as an opportunity to drive innovation and, ultimately, success.

7.2 Implications for Research

My dissertation contributes to the literature on project and project portfolio management in complex environments. It provides new insights into how project portfolios and projects can deal with contradicting situations to succeed. This chapter presents research contributions that focus on overarching topics that two or more studies contribute to different research streams. The dissertation contributes to four fields of research.

Overall, the dissertation highlights the importance of addressing tensions to optimize decision-making and portfolio management processes (Kester et al., 2011; Hahn et al., 2014; Smith, 2014). It underscores

the pivotal role of recognizing and effectively managing tensions within organizational contexts to drive success and innovation (Miron-Spektor et al., 2011). The studies identified positive and negative effects on project portfolio outcomes due to possible tensions. The dissertation contributes to paradox theory, arguing that complex environments impact decision-making through paradoxical tensions (Smith and Lewis, 2011; Smith, 2014; Schad et al., 2016). Additionally, it addresses the need for further research on the antecedents and boundary conditions of paradoxical responses (Hahn et al., 2017).

Second, I contribute to the discourse on sustainability in innovation management as a catalyst for innovative solutions (Claudy et al., 2016; Du et al., 2016; Juntunen et al., 2018; Hoogendoorn et al., 2020; Klein et al., 2021; Fuglsang and Hansen, 2022). Studies D and E demonstrated that incorporating sustainability into an organization's strategy supports decision-makers to select more innovative projects by shifting their attention toward sustainability. The requirements for sustainable products and development may lead to restrictions that strengthen technological orientation and generate innovative products. This dissertation confirms the positive relationship between portfolio innovativeness and portfolio success (Salomo et al., 2008; Kaufmann et al., 2021). These innovative products ultimately contribute to the development of new markets and technologies, which positively impacts the portfolio's success (Kock et al., 2011). Further, this dissertation demonstrates that even contradictions related to sustainability can be advantageous, thereby expanding the contribution to sustainability tensions research (Hahn et al., 2014; Hahn et al., 2017; Hengst et al., 2020). Studies C and E suggest that sustainability can promote innovation through tensions at both the portfolio and individual project levels. It aligns with the premise of paradox theory, which means that organizations can leverage paradoxes to achieve positive outcomes (Smith and Lewis, 2011; Carmine and De Marchi, 2022). Study C demonstrates that local agglomeration effects can cause tensions or trade-offs between partners at the urban level. However, these tensions can also lead to innovative solutions. Study E suggests tensions between pursuing sustainability and competitive strategies can foster innovation within the portfolio. Although tensions may complicate decision-making in the portfolio, managing these tensions can be easier under certain circumstances.

Third, with Studies A, B, and E, this dissertation contributes to the literature on contexts in projects and project portfolio management (Shenhar, 2001; Teller et al., 2012; Martinsuo and Geraldi, 2020; Globocnik et al., 2022). The three studies emphasize the importance of contingency factors influencing project or portfolio success. Study A examines the impact of PPM on projects and provides empirical evidence for multi-level research between portfolios and projects, suggesting that certain factors can have adverse effects on projects (Martinsuo and Lehtonen, 2007; Teller et al., 2012; Nguyen et al., 2018). Study E examines the influence of portfolio characteristics on PPM. Consistent with prior research, contingency factors, such as innovation climate and entrepreneurial orientation, positively impact portfolios and their outcomes (Kock and Gemünden, 2020; Kaufmann et al., 2021). In both studies, the contingency factors act as a moderator for the investigated relationships. On the other hand,

study B examines dynamic capabilities as an antecedent to portfolio agility and success. Therefore, project portfolio management must consider portfolio stakeholders' internal and external context when making decisions, with dynamic capabilities serving as the underlying framework (Killen et al., 2012; Hoffmann et al., 2020). Thus, all three studies contribute to contingency theory (Donaldson, 2001).

Lastly, this dissertation reveals, through studies A and B, the positive effect of agility in project portfolio management, confirming its importance in today's complex organizational environment (Serrador and Pinto, 2015; Stettina and Horz, 2015; Kock and Gemünden, 2016; Kaufmann et al., 2020). Study A examines the impact of agile practices on Teamwork Quality and project success, while study B focuses on portfolio agility and its implications for portfolio success. Both texts delve into different facets of agility in the portfolio management contexts. Study A examines practices that promote faster exchange between team members and faster product adaptiveness, contributing to research on agile practices in project management (Moe et al., 2008; Moe et al., 2010; Hoda et al., 2012; Dingsøyr et al., 2018; Bäcklander, 2019). On the other hand, study B contributes to understanding agility as a capability in PPM by identifying antecedents and integrating them into decision-making frameworks. Thus, it contributes to the literature on portfolio agility, confirming its positive relation to portfolio success (Kester et al., 2014; Kock and Gemünden, 2016; Hoffmann et al., 2020; Kaufmann et al., 2020). Additionally, both studies demonstrate the significance of adaptability to environmental conditions and portfolio processes (Killen et al., 2012; Petit, 2012; Park et al., 2017). Study A emphasizes this point by revealing the adverse impact of traditional PPM processes that have not been modified. Study B, on the other hand, highlights the importance of continually questioning PPM processes (e.g., reconfiguring) through the positive effects this can have on the portfolio.

7.3 Implications for Practice

This chapter outlines the practical implications of the dissertation's findings. It highlights the implications for decision-makers in their behavior, what they can do to shape awareness among their employees through culture and training, and provides implications for portfolios on how agility can support sustainability initiatives.

From a sustainability perspective, managers can draw several implications from this paper. First, it is increasingly essential that portfolio decision-makers understand how their attention is shaped (Kock and Gemünden, 2020; Kaufmann et al., 2021). This dissertation demonstrates that highlighting sustainable topics and tensions can enhance portfolio innovativeness. Portfolio managers can utilize this knowledge to implement portfolio structuring and monitoring methods, giving appropriate attention to strategically relevant issues. Establishing a strategic bucket for project selection is an example of making sustainability more visible (Hutchison-Krupat and Kavadias, 2015). The bucket could include projects that pay particular attention to sustainability, such as acting in a resource-conserving manner

or creating explicit sustainability initiatives as the main objective of their project. Further, project monitoring could incorporate sustainability aspects explicitly by utilizing indicators (Sabini et al., 2019). These indicators can include social indicators such as sick leave days or the number of accidents at work and ecological indicators like damage to resource availability or the ecosystem (Ma et al., 2020). The dissertation emphasizes that promoting a holistic orientation toward sustainability is crucial.

Thus, second, this dissertation found that employees at all levels, not just those in higher positions, play a role in influencing sustainability orientation (Adams et al., 2016). The cultural dimension of sustainability orientation reflects whether employees understand its essential role in the project portfolio. To promote understanding of new topics, such as sustainability in project management, it is crucial to enable an exchange between project managers and their teams. A project manager community can classify new topics, identify problems, and share best practices for the project management environment. Additionally, portfolio managers and decision-makers should foster an innovation environment where employees and project managers can freely exchange ideas and express concerns (Kaufmann et al., 2021). This dissertation found that an innovation climate facilitates the transformation of tensions into innovative ideas, consequently leading to the proposal and selection of innovative project initiatives.

Third, this dissertation has explored the impact of regulation on sustainability. The influence of regulatory investment quotas imposed by authorities was prominently demonstrated in the case of living labs, where project participants depended on them. This example highlights another important aspect of sustainability: regulations significantly encourage a firm's sustainability practices (Kern et al., 2019). Companies should consider governments as additional stakeholders that impact their business and, thus, their project portfolio (Kassinis and Vafeas, 2006). Portfolio management needs to develop skills to anticipate legislative changes in advance, and as highlighted by study B, dynamic capabilities serve as an antecedent for agility in project portfolios. Thus, utilizing methodologies like roadmapping or foresight tools can aid in identifying regulatory shifts and trends (Bengtsson and Lindkvist, 2017; Kock and Gemünden, 2019). Moreover, decision-makers should constantly communicate with the authorities/government to become active co-creators of change rather than just passive recipients. The living labs case demonstrates that governmental bodies have accepted proposals from companies and universities.

In addition, this dissertation demonstrates that agile practices benefit project team collaboration and contribute to project success. By integrating aspects of agile practices into their everyday project work, project managers and team members can reap the benefits without explicitly adopting agile methods. For instance, integrating customer/user feedback into a traditionally managed project can be beneficial. Regular exchange between team members is essential, especially as the COVID-19 pandemic has made remote working more prevalent (Chong et al., 2020). Thus, project teams should implement the

appropriate agile practices for their processes. The dissertation demonstrates that conventional PPM practices can result in issues within project teams. Agile project teams should constantly communicate with portfolio management to address problems early and prevent internal discussions. It is essential to prioritize early problem-solving and prevent conflicts from arising.

Lastly, certifications and internal training can train employees in new methods. Training is helpful not only for agility but also for sustainability, sharpening employees' understanding. However, the selection of certifications should be tailored to the company, as standardized options may not be well-received by project managers due to their heavy workload (Ekrot et al., 2018). Further, Sabini et al. (2017) argue that sustainable certification at established PM associations is not yet fully developed and suggest using alternatives such as internal training.

7.4 Future Research

The studies' results offer a comprehensive understanding of when tensions arise in agile practices and the antecedents contributing to optimal agility implementation at the portfolio level. This dissertation demonstrates the project and portfolio-level tensions due to a sustainable orientation. It also explores the contingencies that portfolios and projects can use to their advantage when faced with these tensions. Future research could quantify the results with independent sources, delve deeper into the nature of the tensions, and explore the combination of agility and sustainability. In the following section, I will tap into opportunities for future research.

This dissertation has demonstrated that a sustainability orientation and sustainability tensions can contribute to the innovativeness of the project portfolio under the appropriate conditions. Although perceived tensions cannot be measured objectively, objective measures can substitute a company's strategic orientation and resulting outcome. In recent years, the focus on sustainability has shifted towards objective assessments of companies' implementation of sustainable practices, aided by AI and access to larger data sets (Marquis et al., 2016; Luo et al., 2017). For example, research can use various sources, including annual reports, regulatory filings, and pollution emissions, to objectively measure greenwashing. However, previous research has focused on the company level, where data is more accessible to the public (e.g., through public sustainability reports or databases). Investigating project portfolios or individual projects is more challenging, as access to this level of data typically requires direct contact with the company. Additionally, standardization between projects and portfolios is likely even more difficult than at the company level. Future research could address this problem in two ways. First, a qualitative pre-study could identify measurable Key Performance Indicators (KPIs) for sustainability at the portfolio and project level (Sánchez, 2015). Second, studies focusing on specific industries could provide a better basis for comparison. The fact that some industries, such as the

construction sector, already prioritize environmental sustainability due to regulation may result in varying levels of sustainability orientation between industries (Aarseth et al., 2017). We need further investigation to scrutinize how organizations deal with tensions. More mature industries may experience less tension, but it could also be that these industries are more aware of tensions and perceive them more strongly.

This dissertation examines local sustainability projects and their trade-offs resulting from agglomeration effects. It considers the project level and how various stakeholders collaborate locally. However, participation in living labs can also have an inward impact on organizations, their sustainability awareness, and its effect on innovativeness and, possibly even more specifically, on project portfolios. University-industry collaboration research informs us that those collaborations impact the front-end success of R&D groups due to additional knowledge and resources. Universities conduct preliminary studies and contribute creative ideas to research projects (Gretsch et al., 2019). Similar justifications can be applied to living labs, which, among other things, provide investment and resources to companies. However, compared to the usual university-industry collaborations, living labs create a benefit that is not necessarily financial but serves the city's citizens, for example. Due to the rarity of living labs, few studies have been conducted at the company level. The Federal Ministry for Economic Affairs and Energy (2021) predicts a rise in decentralized sustainability projects and investments in the upcoming years. A quantitative study could explore the relationship between sustainability orientation, innovativeness, and participation in living labs.

Based on the findings on agile practices, future research could examine the nature of tensions between agile projects and traditional portfolio management. Study A demonstrated disadvantageous outcomes for agile projects and when tensions arise but fell short of identifying explicit management strategies. Similar to sustainability research (Hengst et al., 2020), future research could identify the types of tensions and recommend how to manage them. An ethnographic field study that accompanies introducing agile practices to project-based organizations could provide further insights. This dissertation proves that agility can be successfully implemented at the portfolio level under appropriate conditions (Kock and Gemünden, 2016). Former research qualitatively identified paradoxical tensions when trying to introduce agility on an organizational level (Ambituuni et al., 2021; Strode et al., 2022). Future research could quantify these tensions to identify framework conditions (moderators) and where they can be beneficial. The dissertation examined the interaction of two organizational levels (i.e., portfolio and project level). Contingency theory informs us that entities, such as projects, never operate in isolation but in an environment (Shenhar, 2001; Teller et al., 2012). Thus, future research could explore the interplay between other organizational levels, such as external collaborations with companies that may or may not work agilely. Further tensions may arise between an agile project-based organization, such as the project portfolio, and a traditionally operating line organization.

Finally, the question arises whether agility or agile practices can help companies become more sustainable. Previous research has emphasized that strategic agility positively relates to environmental innovation in organizations optimizing resource management (Bouguerra et al., 2023). Thus, the combination of this dissertation's field of interest constitutes an interesting research field. Furthermore, agility may hinder a company's sustainable orientation as projects are frequently adjusted to take advantage of current opportunities, leading decision-makers to overlook the long-term perspective needed for sustainability. Future research could examine the relationship between sustainability orientation and portfolio success under consideration of agility as a moderator. While I defined agility as adaptivity to environmental conditions in this dissertation, the differentiation between various types of agility, such as strategic agility or scaled agile practices at the portfolio level, remained unexplored.

References

Aarseth, W., Ahola, T., Aaltonen, K., Okland, A. and Andersen, B. (2017). Project sustainability strategies: A systematic literature review. *International Journal of Project Management* 35 (6), S. 1071-1083.

Abetti, P. A. (2002). From science to technology to products and profits. *Journal of Business Venturing* 17 (1), S. 83-98.

Aboelmaged, M. and Hashem, G. (2019). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. *Journal of Cleaner Production* 220, S. 853-863.

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D. and Overy, P. (2016). Sustainability-oriented Innovation: A Systematic Review. *International Journal of Management Reviews* 18 (2), S. 180-205.

Aghajani, M., Ruge, G. and Jugdev, K. (2023). An Integrative Review of Project Portfolio Management Literature: Thematic Findings on Sustainability Mindset, Assessment, and Integration. *Project Management Journal*.

Ahire, S. L. and Devaraj, S. (2001). An empirical comparison of statistical construct validation approaches. *Ieee Transactions on Engineering Management* 48 (3), S. 319-329.

Alcácer, J. and Chung, W. (2007). Location Strategies and Knowledge Spillovers. *Management Science* 53 (5), S. 760-776.

Amabile, T. M., Conti, R., Coon, H., Lazenby, J. and Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal* 39 (5), S. 1154-1184.

Ambituuni, A., Azizsafaei, F. and Keegan, A. (2021). HRM operational models and practices to enable strategic agility in PBOs: Managing paradoxical tensions. *Journal of Business Research* 133, S. 170-182.

Anderson, N. R. and West, M. A. (1998). Measuring climate for work group innovation: development and validation of the team climate inventory. *Journal of Organizational Behavior* 19 (3), S. 235-258.

Andriopoulos, C., Gotsi, M., Lewis, M. W. and Ingram, A. E. (2017). Turning the Sword: How NPD Teams Cope with Front-End Tensions. *Journal of Product Innovation Management* 35 (3), S. 427-445.

Andriopoulos, C. and Lewis, M. W. (2009). Exploitation-Exploration Tensions and Organizational Ambidexterity: Managing Paradoxes of Innovation. *Organization Science* 20 (4), S. 696-717.

Audretsch, D. B. and Feldman, M. P. (2004): Chapter 61 - Knowledge Spillovers and the Geography of Innovation. Handbook of Regional and Urban Economics. J. V. Henderson and J.-F. Thisse, Elsevier. 4: S. 2713-2739.

Bäcklander, G. (2019). Doing complexity leadership theory: How agile coaches at Spotify practise enabling leadership. *Creativity and Innovation Management* 28 (1), S. 42-60.

Baham, C. and Hirschheim, R. (2022). Issues, challenges, and a proposed theoretical core of agile software development research. *Information Systems Journal* 32 (1), S. 103-129.

Bansal, P. and Song, H.-C. (2017). Similar But Not the Same: Differentiating Corporate Sustainability from Corporate Responsibility. *Academy of Management Annals* 11 (1), S. 105-149.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management* 17 (1), S. 99-120.

Beal, D. J., Cohen, R. R., Burke, M. J. and McLendon, C. L. (2003). Cohesion and performance in groups: a meta-analytic clarification of construct relations. *J Appl Psychol* 88 (6), S. 989-1004.

Bechtel, J., Kaufmann, C. and Kock, A. (2022). Agile Projects in Nonagile Portfolios: How Project Portfolio Contingencies Constrain Agile Projects' Teamwork Quality. *Ieee Transactions on Engineering Management* 69 (6), S. 3514-3528.

Beck, K., Beedle, M., Van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A. and Jeffries, R. (2001). Manifesto for agile software development.

Bengtsson, M. and Lindkvist, L. (2017). Mapping the Road to Future Projects: Roadmapping as a Balancing and Transformation Process. *Project Management Journal* 48 (2), S. 39-54.

Beringer, C., Jonas, D. and Kock, A. (2013). Behavior of internal stakeholders in project portfolio management and its impact on success. *International Journal of Project Management* 31 (6), S. 830-846.

Bertels, H. M. J., Kleinschmidt, E. J. and Koen, P. A. (2011). Communities of Practice versus Organizational Climate: Which One Matters More to Dispersed Collaboration in the Front End of Innovation?*. *Journal of Product Innovation Management*, S. no-no.

Bianchi, M., Marzi, G. and Guerini, M. (2020). Agile, Stage-Gate and their combination: Exploring how they relate to performance in software development. *Journal of Business Research* 110, S. 538-553.

Bitencourt, C. C., Santini, F. D., Ladeira, W., Santos, A. C. and Teixeira, E. K. (2020). The extended dynamic capabilities model: A meta-analysis. *European Management Journal* 38 (1), S. 108-120.

Bos-Brouwers, H. E. J. (2009). Corporate sustainability and innovation in SMEs: evidence of themes and activities in practice. *Business Strategy and the Environment*, S. n/a-n/a.

Bouguerra, A., Hughes, M., Rodgers, P., Stokes, P. and Tatoglu, E. (2023). Confronting the grand challenge of environmental sustainability within supply chains: How can organizational strategic agility drive environmental innovation? *Journal of Product Innovation Management*.

Bowen, H. P. and Wiersema, M. F. (1999). Matching method to paradigm in strategy research: limitations of cross-sectional analysis and some methodological alternatives. *Strategic Management Journal* 20 (7), S. 625-636.

Brook, J. W. and Pagnanelli, F. (2014). Integrating sustainability into innovation project portfolio management - A strategic perspective. *Journal of Engineering and Technology Management* 34, S. 46-62.

Brundtland, G. H. (1987). Report of the World Commission on environment and development:" our common future.". UN.

Burns, T. and Stalker, G. (1961). The management of innovation. *Tavistock, London*, S. 120-122.

Canonico, P. and Soderlund, J. (2010). Getting control of multi-project organizations: Combining contingent control mechanisms. *International Journal of Project Management* 28 (8), S. 796-806.

Capozza, C., Salomone, S. and Somma, E. (2018). Local industrial structure, agglomeration economies and the creation of innovative start-ups: evidence from the Italian case. *Entrepreneurship & Regional Development* 30 (7-8), S. 749-775.

Caragliu, A. and Del Bo, C. F. (2019). Smart innovative cities: The impact of Smart City policies on urban innovation. *Technological Forecasting and Social Change* 142, S. 373-383.

Carlino, G. and Kerr, W. R. (2015): Chapter 6 - Agglomeration and Innovation. Handbook of Regional and Urban Economics. G. Duranton, J. V. Henderson and W. C. Strange, Elsevier. 5: S. 349-404.

Carmine, S. and De Marchi, V. (2022). Reviewing Paradox Theory in Corporate Sustainability Toward a Systems Perspective. *Journal of Business Ethics* 184 (1), S. 139-158.

Carollo, L. and Guerci, M. (2017). 'Activists in a Suit': Paradoxes and Metaphors in Sustainability Managers' Identity Work. *Journal of Business Ethics* 148 (2), S. 249-268.

Chakravarty, A., Grewal, R. and Sambamurthy, V. (2013). Information Technology Competencies, Organizational Agility, and Firm Performance: Enabling and Facilitating Roles. *Information Systems Research* 24 (4), S. 976-997.

Chan, D. (1998). Functional relations among constructs in the same content domain at different levels of analysis: A typology of composition models. *Journal of Applied Psychology* 83 (2), S. 234-246.

Chang, S. J., van Witteloostuijn, A. and Eden, L. (2010). From the Editors: Common method variance in international business research. *Journal of International Business Studies* 41 (2), S. 178-184.

Chen, C. J. (2007). Information technology, organizational structure, and new product development-the mediating effect of cross - Functional team interaction. *Ieee Transactions on Engineering Management* 54 (4), S. 687-698.

Chen, F. F., Sousa, K. H. and West, S. G. (2005). Teacher's Corner: Testing Measurement Invariance of Second-Order Factor Models. *Structural Equation Modeling: A Multidisciplinary Journal* 12 (3), S. 471-492.

Chen, M. S., Eweje, G. and Kennedy, J. C. (2021). Managerial sensemaking of tensions in sustainability: Empirical evidence from Chinese and New Zealand business partnerships. *Journal of Cleaner Production* 319.

Cheng, C. C. J. (2018). Sustainability Orientation, Green Supplier Involvement, and Green Innovation Performance: Evidence from Diversifying Green Entrants. *Journal of Business Ethics* 161 (2), S. 393-414.

Chong, S., Huang, Y. and Chang, C. D. (2020). Supporting interdependent telework employees: A moderated-mediation model linking daily COVID-19 task setbacks to next-day work withdrawal. *J Appl Psychol* 105 (12), S. 1408-1422.

Claudy, M. C., Garcia, R. and O'Driscoll, A. (2014). Consumer resistance to innovation—a behavioral reasoning perspective. *Journal of the Academy of Marketing Science* 43 (4), S. 528-544.

Claudy, M. C., Peterson, M. and Pagell, M. (2016). The Roles of Sustainability Orientation and Market Knowledge Competence in New Product Development Success. *Journal of Product Innovation Management* 33 (S1), S. 72-85.

Clegg, S., Killen, C. P., Biesenthal, C. and Sankaran, S. (2018). Practices, projects and portfolios: Current research trends and new directions. *International Journal of Project Management* 36 (5), S. 762-772.

Coffay, M., Coenen, L. and Tveteras, R. (2022). Effectuated sustainability: Responsible Innovation Labs for impact forecasting and assessment. *Journal of Cleaner Production* 376.

Cohen, S. G. and Bailey, D. E. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of Management* 23 (3), S. 239-290.

Compagnucci, L., Spigarelli, F., Coelho, J. and Duarte, C. (2021). Living Labs and user engagement for innovation and sustainability. *Journal of Cleaner Production* 289.

Conboy, K. (2009). Agility from First Principles: Reconstructing the Concept of Agility in Information Systems Development. *Information Systems Research* 20 (3), S. 329-354.

Cooper, R., Edgett, S. and Kleinschmidt, E. (2001). Portfolio management for new product development: results of an industry practices study. *R & D Management* 31 (4), S. 361-380.

Cooper, R. G., Edgett, S. J. and Kleinschmidt, E. J. (1999). New product portfolio management: Practices and performance. *Journal of Product Innovation Management* 16 (4), S. 333-351.

Cooper, R. G., Edgett, S. J. and Kleinschmidt, E. J. (2001). Portfolio management for new products.

Copola Azenha, F., Aparecida Reis, D. and Leme Fleury, A. (2021). The role and characteristics of hybrid approaches to project management in the development of technology-based products and services. *Project Management Journal* 52 (1), S. 90-110.

Covin, J. G. and Slevin, D. P. (1989). Strategic Management of Small Firms in Hostile and Benign Environments. *Strategic Management Journal* 10 (1), S. 75-87.

Cowan, R. and Zinovyeva, N. (2013). University effects on regional innovation. *Research Policy* 42 (3), S. 788-800.

Cuganesan, S. and Floris, M. (2020). Investigating perspective taking when infrastructure megaproject teams engage local communities: Navigating tensions and balancing perspectives. *International Journal of Project Management* 38 (3), S. 153-164.

Dangelico, R. M., Pontrandolfo, P. and Pujari, D. (2013). Developing Sustainable New Products in the Textile and Upholstered Furniture Industries: Role of External Integrative Capabilities. *Journal of Product Innovation Management* 30 (4), S. 642-658.

Daniel, E. M., Ward, J. M. and Franken, A. (2014). A dynamic capabilities perspective of IS project portfolio management. *Journal of Strategic Information Systems* 23 (2), S. 95-111.

David, M. and Gross, M. (2019). Futurizing politics and the sustainability of real-world experiments: what role for innovation and exnovation in the German energy transition? *Sustainability Science* 14 (4), S. 991-1000.

Davies, A. and Brady, T. (2000). Organisational capabilities and learning in complex product systems: towards repeatable solutions. *Research Policy* 29 (7-8), S. 931-953.

Davies, A. and Brady, T. (2016). Explicating the dynamics of project capabilities. *International Journal of Project Management* 34 (2), S. 314-327.

De Jong, B. A. and Elfring, T. (2010). How Does Trust Affect the Performance of Ongoing Teams? The Mediating Role of Reflexivity, Monitoring, and Effort. *Academy of Management Journal* 53 (3), S. 535-549.

Dietrich, P. and Lehtonen, P. (2005). Successful management of strategic intentions through multiple projects – Reflections from empirical study. *International Journal of Project Management* 23 (5), S. 386-391.

Dingsøyr, T., Moe, N. B. and Seim, E. A. (2018). Coordinating knowledge work in multiteam programs: findings from a large-scale agile development program. *Project Management Journal* 49 (6), S. 64-77.

Dixit, R. K. and Pindyck, R. S. (1994). Investment under uncertainty. Princeton university press.

Dixon-Fowler, H. R., Slater, D. J., Johnson, J. L., Ellstrand, A. E. and Romi, A. M. (2012). Beyond "Does it Pay to be Green?" A Meta-Analysis of Moderators of the CEP–CFP Relationship. *Journal of Business Ethics* 112 (2), S. 353-366.

Donaldson, L. (2001). The contingency theory of organizations. Sage.

Drury-Grogan, M. L. (2021). The Changes in Team Cognition and Cognitive Artifact Use During Agile Software Development Project Management. *Project Management Journal* 52 (2), S. 127-145.

Du, S. L., Yalcinkaya, G. and Bstieler, L. (2016). Sustainability, Social Media Driven Open Innovation, and New Product Development Performance. *Journal of Product Innovation Management* 33 (S1), S. 55-71.

Duranton, G. and Puga, D. (2004): Chapter 48 - Micro-Foundations of Urban Agglomeration Economies. Handbook of Regional and Urban Economics. J. V. Henderson and J.-F. Thisse, Elsevier. 4: S. 2063-2117.

Duranton, G. and Puga, D. (2004): Micro-foundations of urban agglomeration economies. Handbook of regional and urban economics, Elsevier. 4: S. 2063-2117.

Dvarioniene, J., Gurauskiene, I., Gecevicius, G., Trummer, D. R., Selada, C., Marques, I. and Cosmi, C. (2015). Stakeholders involvement for energy conscious communities: The Energy Labs experience in 10 European communities. *Renewable Energy* 75, S. 512-518.

Dyba, T. and Dingsoyr, T. (2008). Empirical studies of agile software development: A systematic review. *Information and Software Technology* 50 (9-10), S. 833-859.

Easley, R. F., Devaraj, S. and Crant, J. M. (2003). Relating collaborative technology use to teamwork quality and performance: An empirical analysis. *Journal of Management Information Systems* 19 (4), S. 247-268.

Edmondson, C. and Nembhard, I. M. (2009). Product Development and Learning in Project Teams: The Challenges Are the Benefits. *Journal of Product Innovation Management* 26 (2), S. 123-138.

Einhorn, F., Marnewick, C. and Meredith, J. (2019). Achieving strategic benefits from business IT projects: The critical importance of using the business case across the entire project lifetime. *International Journal of Project Management* 37 (8), S. 989-1002.

Eisenhardt, K. M. (1989). Building Theories from Case-Study Research. *Academy of Management Review* 14 (4), S. 532-550.

Eisenhardt, K. M. and Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal* 21 (10-11), S. 1105-1121.

Ekrot, B., Rank, J., Kock, A. and Gemunden, H. G. (2018). Retaining and satisfying project managers - antecedents and outcomes of project managers' perceived organizational support. *International Journal of Human Resource Management* 29 (12), S. 1950-1971.

Elkington, J. (1994). Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development. *California Management Review* 36 (2), S. 90-100.

Elkington, J. (1998). ACCOUNTING FOR THE TRIPLE BOTTOM LINE. *Measuring Business Excellence* 2 (3), S. 18-22.

Elzen, B. and Wieczorek, A. (2005). Transitions towards sustainability through system innovation. *Technological Forecasting and Social Change* 72 (6), S. 651-661.

Etzion, D., Gehman, J., Ferraro, F. and Avidan, M. (2017). Unleashing sustainability transformations through robust action. *Journal of Cleaner Production* 140, S. 167-178.

Eva, N., Robin, M., Sendjaya, S., van Dierendonck, D. and Liden, R. C. (2019). Servant Leadership: A systematic review and call for future research. *Leadership Quarterly* 30 (1), S. 111-132.

Fainshmidt, S., Pezeshkan, A., Frazier, M. L., Nair, A. and Markowski, E. (2016). Dynamic Capabilities and Organizational Performance: A Meta-Analytic Evaluation and Extension. *Journal of Management Studies* 53 (8), S. 1348-1380.

Fainshmidt, S., Wenger, L., Pezeshkan, A. and Mallon, M. R. (2018). When do Dynamic Capabilities Lead to Competitive Advantage? The Importance of Strategic Fit. *Journal of Management Studies* 56 (4), S. 758-787.

Federal Ministry for Economic Affairs and Energy (2021). Förderbekanntmachung: Angewandte nichtnukleare Forschungsförderung im 7. Energieforschungsprogramm „Innovationen für die Energiewende“. F. M. f. E. A. a. Energy. Berlin.

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry* 12 (2), S. 219-245.

Fornell, C. and Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research* 18 (1), S. 39-50.

Fowler, M. and Highsmith, J. (2001). "The agile manifesto, in: Software Development, Issue on Agile Methodologies." Retrieved March 5th 2020.

Fuenfschilling, L., Frantzeskaki, N. and Coenen, L. (2018). Urban experimentation & sustainability transitions. *European Planning Studies* 27 (2), S. 219-228.

Fuglsang, L. and Hansen, A. V. (2022). Framing improvements of public innovation in a living lab context: Processual learning, restrained space and democratic engagement. *Research Policy* 51 (1).

Gabler, C. B., Richey, R. G. and Rapp, A. (2015). Developing an eco-capability through environmental orientation and organizational innovativeness. *Industrial Marketing Management* 45, S. 151-161.

Gao, Y. C., Hu, Y. M., Liu, X. L. and Zhang, H. R. (2021). Can public R&D subsidy facilitate firms? exploratory innovation? The heterogeneous effects between central and local subsidy programs. *Research Policy* 50 (4).

Gardiner, P. D. and Stewart, K. (2000). Revisiting the golden triangle of cost, time and quality: the role of NPV in project control, success and failure. *International Journal of Project Management* 18 (4), S. 251-256.

Gascó, M. (2017). Living labs: Implementing open innovation in the public sector. *Government Information Quarterly* 34 (1), S. 90-98.

Gatignon, H. and Xuereb, J.-M. (1997). Strategic Orientation of the Firm and New Product Performance. *Journal of Marketing Research* 34 (1), S. 77-90.

Gebert, D., Boerner, S. and Kearney, E. (2010). Fostering Team Innovation: Why Is It Important to Combine Opposing Action Strategies? *Organization Science* 21 (3), S. 593-608.

Gemino, A., Horner Reich, B. and Serrador, P. M. (2020). Agile, Traditional, and Hybrid Approaches to Project Success: Is Hybrid a Poor Second Choice? *Project Management Journal* 52 (2), S. 161-175.

Gemünden, H. G., Lehner, P. and Kock, A. (2018). The project-oriented organization and its contribution to innovation. *International Journal of Project Management* 36 (1), S. 147-160.

Gemünden, H. G., Salomo, S. and Krieger, A. (2005). The influence of project autonomy on project success. *International Journal of Project Management* 23 (5), S. 366-373.

George, G., Howard-Grenville, J., Joshi, A. and Tihanyi, L. (2016). Understanding and Tackling Societal Grand Challenges through Management Research. *Academy of Management Journal* 59 (6), S. 1880-1895.

Globocnik, D., Haufler, B. P. and Salomo, S. (2022). Organizational antecedents to bootlegging and consequences for the newness of the innovation portfolio. *Journal of Product Innovation Management* 39 (5), S. 717-745.

Goffin, K., Åhlström, P., Bianchi, M. and Richtnér, A. (2019). Perspective: State-of-the-Art: The Quality of Case Study Research in Innovation Management. *Journal of Product Innovation Management* 36 (5), S. 586-615.

Gomes, L. A. d. V., Castillo-Ospina, D. A., Facin, A. L. F., Ferreira, C. d. S. and Ometto, A. R. (2023). Circular ecosystem innovation portfolio management. *Technovation* 124.

Gretsch, O., Salzmann, E. C. and Kock, A. (2019). University-industry collaboration and front-end success: the moderating effects of innovativeness and parallel cross-firm collaboration. *R&D Management* 49 (5), S. 835-849.

Guertler, M. R. and Sick, N. (2021). Exploring the enabling effects of project management for SMEs in adopting open innovation ? A framework for partner search and selection in open innovation projects. *International Journal of Project Management* 39 (2), S. 102-114.

Gutiérrez, E. and Magnusson, M. (2014). Dealing with legitimacy: A key challenge for Project Portfolio Management decision makers. *International Journal of Project Management* 32 (1), S. 30-39.

Hahn, T., Figge, F., Pinkse, J. and Preuss, L. (2017). A Paradox Perspective on Corporate Sustainability: Descriptive, Instrumental, and Normative Aspects. *Journal of Business Ethics* 148 (2), S. 235-248.

Hahn, T. and Pinkse, J. (2022). A paradox approach to sustainable product-service systems. *Industrial Marketing Management* 105, S. 182-189.

Hahn, T., Pinkse, J., Preuss, L. and Figge, F. (2015). Ambidexterity for Corporate Social Performance. *Organization Studies* 37 (2), S. 213-235.

Hahn, T., Pinkse, J., Preuss, L. and Figge, F. (2015). Tensions in Corporate Sustainability: Towards an Integrative Framework. *Journal of Business Ethics* 127 (2), S. 297-316.

Hahn, T., Preuss, L., Pinkse, J. and Figge, F. (2014). Cognitive Frames in Corporate Sustainability: Managerial Sensemaking with Paradoxical and Business Case Frames. *Academy of Management Review* 39 (4), S. 463-487.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E. and Tatham, R. L. (1998). Multivariate data analysis. Prentice hall Upper Saddle River, NJ.

Hair, J. F., Hult, G. T. M., Ringle, C. and Sarstedt, M. (2017). A primer on partial least squares structural equation modeling (PLS-SEM). Sage publications.

Hall, J. and Vredenburg, H. (2003). The challenges of innovating for sustainable development. *Mit Sloan Management Review* 45 (1), S. 61-68.

Hall, J. K., Daneke, G. A. and Lenox, M. J. (2010). Sustainable development and entrepreneurship: Past contributions and future directions. *Journal of Business Venturing* 25 (5), S. 439-448.

Hallstedt, S., Ny, H., Robert, K. H. and Broman, G. (2010). An approach to assessing sustainability integration in strategic decision systems for product development. *Journal of Cleaner Production* 18 (8), S. 703-712.

Hanisch, B. and Wald, A. (2012). A Bibliometric View on the Use of Contingency Theory in Project Management Research. *Project Management Journal* 43 (3), S. 4-23.

Hansen, E. G., Wicki, S. and Schaltegger, S. (2018). Structural ambidexterity, transition processes, and integration trade-offs: a longitudinal study of failed exploration. *R&D Management* 49 (4), S. 484-508.

Hansen, L. K. and Svejvig, P. (2022). Seven Decades of Project Portfolio Management Research (1950-2019) and Perspectives for the Future. *Project Management Journal* 53 (3), S. 277-294.

Hayes, A. F. and Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *Br J Math Stat Psychol* 67 (3), S. 451-470.

Heimeriks, K. H., Schijven, M. and Gates, S. (2012). Manifestations of Higher-Order Routines: The Underlying Mechanisms of Deliberate Learning in the Context of Postacquisition Integration. *Academy of Management Journal* 55 (3), S. 703-726.

Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D. and Winter, S. G. (2009). Dynamic capabilities: Understanding strategic change in organizations. John Wiley & Sons.

Helfat, C. E. and Peteraf, M. A. (2015). Managerial Cognitive Capabilities and the Microfoundations of Dynamic Capabilities. *Strategic Management Journal* 36 (6), S. 831-850.

Hengst, I. A., Jarzabkowski, P., Hoegl, M. and Muethel, M. (2020). Toward a Process Theory of Making Sustainability Strategies Legitimate in Action. *Academy of Management Journal* 63 (1), S. 246-271.

Hennel, P. and Rosenkranz, C. (2021). Investigating the "Socio" in Socio-Technical Development: The Case for Psychological Safety in Agile Information Systems Development. *Project Management Journal* 52 (1), S. 11-30.

Hervas-Oliver, J. L., Sempere-Ripoll, F. and Boronat-Moll, C. (2022). Zooming into firms' location, capabilities and innovation performance: Does agglomeration foster incremental or radical innovation? *European Research on Management and Business Economics* 28 (2).

Highsmith, J. (2009). Agile project management: creating innovative products. Pearson education.

Hinds, P. J. and Mortensen, M. (2005). Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication. *Organization Science* 16 (3), S. 290-307.

Hobbs, B. and Petit, Y. (2017). Agile Methods on Large Projects in Large Organizations. *Project Management Journal* 48 (3), S. 3-19.

Hoda, R. and Murugesan, L. K. (2016). Multi-level agile project management challenges: A self-organizing team perspective. *Journal of Systems and Software* 117, S. 245-257.

Hoda, R., Noble, J. and Marshall, S. (2012). Self-organizing roles on agile software development teams. *IEEE Transactions on Software Engineering* 39 (3), S. 422-444.

Hoegl, M. (2005). Smaller teams–better teamwork: How to keep project teams small. *Business Horizons* 48 (3), S. 209-214.

Hoegl, M. and Gemuenden, H. G. (2001). Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence. *Organization Science* 12 (4), S. 435-449.

Hoegl, M. and Proserpio, L. (2004). Team member proximity and teamwork in innovative projects. *Research Policy* 33 (8), S. 1153-1165.

Hoegl, M., Weinkauf, K. and Gemuenden, H. G. (2004). Interteam coordination, project commitment, and teamwork in multiteam R&D projects: A longitudinal study. *Organization Science* 15 (1), S. 38-55.

Hoffmann, D., Ahlemann, F. and Reining, S. (2020). Reconciling alignment, efficiency, and agility in IT project portfolio management: Recommendations based on a revelatory case study. *International Journal of Project Management* 38 (2), S. 124-136.

Hoogendoorn, B., van der Zwan, P. and Thurik, R. (2020). Goal heterogeneity at start-up: are greener start-ups more innovative? *Research Policy* 49 (10).

Hoonsopon, D. and Puriwat, W. (2021). Organizational Agility: Key to the Success of New Product Development. *Ieee Transactions on Engineering Management* 68 (6), S. 1722-1733.

Hossain, M., Leminen, S. and Westerlund, M. (2019). A systematic review of living lab literature. *Journal of Cleaner Production* 213, S. 976-988.

Hu, J. and Liden, R. C. (2015). Making a Difference in the Teamwork: Linking Team Prosocial Motivation to Team Processes and Effectiveness. *Academy of Management Journal* 58 (4), S. 1102-1127.

Hu, L. T. and Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods* 3 (4), S. 424-453.

Hult, G. T. M., Hurley, R. F. and Knight, G. A. (2004). Innovativeness: Its antecedents and impact on business performance. *Industrial Marketing Management* 33 (5), S. 429-438.

Hutchison-Krupat, J. and Kavadias, S. (2015). Strategic Resource Allocation: Top-Down, Bottom-Up, and the Value of Strategic Buckets. *Management Science* 61 (2), S. 391-412.

Iivonen, K. (2017). Defensive Responses to Strategic Sustainability Paradoxes: Have Your Coke and Drink It Too! *Journal of Business Ethics* 148 (2), S. 309-327.

Ika, L. A. and Pinto, J. K. (2022). The "re-meaning" of project success: Updating and recalibrating for a modern project management. *International Journal of Project Management* 40 (7), S. 835-848.

Ioannou, I. and Serafeim, G. (2012). What drives corporate social performance? The role of nation-level institutions. *Journal of International Business Studies* 43 (9), S. 834-864.

Ivory, S. B. and Brooks, S. B. (2017). Managing Corporate Sustainability with a Paradoxical Lens: Lessons from Strategic Agility. *Journal of Business Ethics* 148 (2), S. 347-361.

Jagani, S. and Hong, P. (2022). Sustainability orientation, byproduct management and business performance: An empirical investigation. *Journal of Cleaner Production* 357.

Jansson, J., Nilsson, J., Modig, F. and Hed Vall, G. (2017). Commitment to Sustainability in Small and Medium-Sized Enterprises: The Influence of Strategic Orientations and Management Values. *Business Strategy and the Environment* 26 (1), S. 69-83.

Jarvis, C. B., MacKenzie, S. B. and Podsakoff, P. M. (2003). A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of Consumer Research* 30 (2), S. 199-218.

Jin, Z., Navare, J. and Lynch, R. (2019). The relationship between innovation culture and innovation outcomes: exploring the effects of sustainability orientation and firm size. *R&D Management* 49 (4), S. 607-623.

Jonas, D., Kock, A. and Gemunden, H. G. (2013). Predicting Project Portfolio Success by Measuring Management Quality-A Longitudinal Study. *Ieee Transactions on Engineering Management* 60 (2), S. 215-226.

Jules, C. and Good, D. (2014). Introduction to Special Issue on Paradox in Context. *The Journal of Applied Behavioral Science* 50 (2), S. 123-126.

Juntunen, J. K., Halme, M., Korsunova, A. and Rajala, R. (2018). Strategies for Integrating Stakeholders into Sustainability Innovation: A Configurational Perspective. *Journal of Product Innovation Management* 36 (3), S. 331-355.

Kale, P. and Singh, H. (2007). Building firm capabilities through learning: The role of the alliance learning process in alliance capability and firm-level alliance success. *Strategic Management Journal* 28 (10), S. 981-1000.

Karna, A., Richter, A. and Riesenkampff, E. (2016). Revisiting the role of the environment in the capabilities-financial performance relationship: A meta-analysis. *Strategic Management Journal* 37 (6), S. 1154-1173.

Kassinis, G. and Vafeas, N. (2006). Stakeholder pressures and environmental performance. *Academy of Management Journal* 49 (1), S. 145-159.

Katz, R. (1982). The Effects of Group Longevity on Project Communication and Performance. *Administrative Science Quarterly* 27 (1), S. 81-104.

Kaufmann, C. and Kock, A. (2022). Does project management matter? The relationship between project management effort, complexity, and profitability. *International Journal of Project Management* 40 (6), S. 624-633.

Kaufmann, C., Kock, A. and Gemunden, H. G. (2020). Emerging strategy recognition in agile portfolios. *International Journal of Project Management* 38 (7), S. 429-440.

Kaufmann, C., Kock, A. and Gemunden, H. G. (2021). Strategic and cultural contexts of real options reasoning in innovation portfolios. *Journal of Product Innovation Management* 38 (3), S. 334-354.

Keinz, P., Hienerth, C., Gemunden, H. G., Killen, C. P. and Sicotte, H. (2021). Special issue: Managing open and user innovation by projects: Sensing, seizing and transforming. *International Journal of Project Management* 39 (2), S. 97-101.

Keller, J., Loewenstein, J. and Yan, J. (2017). Culture, Conditions and Paradoxical Frames. *Organization Studies* 38 (3-4), S. 539-560.

Kern, F., Rogge, K. S. and Howlett, M. (2019). Policy mixes for sustainability transitions: New approaches and insights through bridging innovation and policy studies. *Research Policy* 48 (10).

Kester, L., Griffin, A., Hultink, E. J. and Lauche, K. (2011). Exploring Portfolio Decision-Making Processes. *Journal of Product Innovation Management* 28 (5), S. 641-661.

Kester, L., Hultink, E. J. and Griffin, A. (2014). An Empirical Investigation of the Antecedents and Outcomes of NPD Portfolio Success. *Journal of Product Innovation Management* 31 (6), S. 1199-1213.

Khizar, H. M., Iqbal, M. J., Khalid, J. and Adomako, S. (2022). Addressing the conceptualization and measurement challenges of sustainability orientation: A systematic review and research agenda. *Journal of Business Research* 142, S. 718-743.

Khizar, H. M. U., Iqbal, M. J. and Rasheed, M. I. (2021). Business orientation and sustainable development: A systematic review of sustainability orientation literature and future research avenues. *Sustainable Development* 29 (5), S. 1001-1017.

Killen, C. P. and Hunt, R. A. (2010). Dynamic capability through project portfolio management in service and manufacturing industries. *International Journal of Managing Projects in Business* 3 (1), S. 157-169.

Killen, C. P., Jugdev, K., Drouin, N. and Petit, Y. (2012). Advancing project and portfolio management research: Applying strategic management theories. *International Journal of Project Management* 30 (5), S. 525-538.

Klein, S. P., Spieth, P. and Heidenreich, S. (2021). Facilitating business model innovation: The influence of sustainability and the mediating role of strategic orientations. *Journal of Product Innovation Management* 38 (2), S. 271-288.

Knight, E. and Paroutis, S. (2016). Becoming Salient: The TMT Leader's Role in Shaping the Interpretive Context of Paradoxical Tensions. *Organization Studies* 38 (3-4), S. 403-432.

Kock, A. and Gemünden, H. G. (2016). Antecedents to decision-making quality and agility in innovation portfolio management. *Journal of Product Innovation Management* 33 (6), S. 670-686.

Kock, A. and Gemünden, H. G. (2019). Project Lineage Management and Project Portfolio Success. *Project Management Journal* 50 (5), S. 587-601.

Kock, A. and Gemünden, H. G. (2020). How entrepreneurial orientation can leverage innovation project portfolio management. *R&D Management* 51 (1), S. 40-56.

Kock, A., Gemunden, H. G., Salomo, S. and Schultz, C. (2011). The Mixed Blessings of Technological Innovativeness for the Commercial Success of New Products. *Journal of Product Innovation Management* 28 (s1), S. 28-43.

Kock, A., Heising, W. and Gemuenden, H. G. (2015). How Ideation Portfolio Management Influences Front-End Success. *Journal of Product Innovation Management* 32 (4), S. 539-555.

Kock, A., Schulz, B., Kopmann, J. and Gemünden, H. G. (2020). Project portfolio management information systems' positive influence on performance – the importance of process maturity. *International Journal of Project Management* 38 (4), S. 229-241.

Kopmann, J., Kock, A., Killen, C. P. and Gemunden, H. G. (2015). Business Case Control in Project Portfolios-An Empirical Investigation of Performance Consequences and Moderating Effects. *Ieee Transactions on Engineering Management* 62 (4), S. 529-543.

Kopmann, J., Kock, A., Killen, C. P. and Gemunden, H. G. (2017). The role of project portfolio management in fostering both deliberate and emergent strategy. *International Journal of Project Management* 35 (4), S. 557-570.

Kopmann, J., Kock, A., Killen, C. P. and Gemünden, H. G. (2017). The role of project portfolio management in fostering both deliberate and emergent strategy. *International Journal of Project Management* 35 (4), S. 557-570.

Krebs, J. (2009). Agile portfolio management. Redmond, Washington: Microsoft.

Krieger, B. and Zipperer, V. (2022). Does green public procurement trigger environmental innovations? *Research Policy* 51 (6).

Kroh, J. (2021). Sustain(able) urban (eco)systems: Stakeholder-related success factors in urban innovation projects. *Technological Forecasting and Social Change* 168.

Kronsell, A. and Mukhtar-Landgren, D. (2018). Experimental governance: the role of municipalities in urban living labs. *European Planning Studies* 26 (5), S. 988-1007.

Kuckertz, A. and Wagner, M. (2010). The influence of sustainability orientation on entrepreneurial intentions — Investigating the role of business experience. *Journal of Business Venturing* 25 (5), S. 524-539.

Kurtessis, J. N., Eisenberger, R., Ford, M. T., Buffardi, L. C., Stewart, K. A. and Adis, C. S. (2015). Perceived Organizational Support: A Meta-Analytic Evaluation of Organizational Support Theory. *Journal of Management* 43 (6), S. 1854-1884.

Langley, A., Smallman, C., Tsoukas, H. and Van de Ven, A. H. (2013). Process Studies of Change in Organization and Management: Unveiling Temporality, Activity, and Flow. *Academy of Management Journal* 56 (1), S. 1-13.

Lappi, T., Karvonen, T., Lwakatare, L. E., Aaltonen, K. and Kuvaja, P. (2018). Toward an Improved Understanding of Agile Project Governance A Systematic Literature Review. *Project Management Journal* 49 (6), S. 39-63.

Lauritzen, G. D. and Karafyllia, M. (2019). Perspective: Leveraging Open Innovation through Paradox. *Journal of Product Innovation Management* 36 (1), S. 107-121.

Lee, G. and Xia, W. D. (2010). Toward Agile: An Integrated Analysis of Quantitative and Qualitative Field Data on Software Development Agility. *Mis Quarterly* 34 (1), S. 87-114.

Leffingwell, D. (2007). Scaling software agility: best practices for large enterprises. Boston: Pearson Education.

Leffingwell, D. (2010). Agile software requirements: lean requirements practices for teams, programs, and the enterprise. Boston: Pearson Education.

Leifer, R., McDermott, C. M., O'connor, G. C., Peters, L. S., Rice, M. P. and Veryzer, R. W. (2000). Radical innovation: How mature companies can outsmart upstarts. Harvard Business Press.

Leiringer, R. and Zhang, S. J. (2021). Organisational capabilities and project organising research. *International Journal of Project Management* 39 (5), S. 422-436.

Leminen, S., Rajahonka, M., Westerlund, M. and Hossain, M. (2021). Collaborative innovation for sustainability in Nordic cities. *Journal of Cleaner Production* 328.

LePine, J. A., Piccolo, R. F., Jackson, C. L., Mathieu, J. E. and Saul, J. R. (2008). A meta-analysis of teamwork processes: Tests of a multidimensional model and relationships with team effectiveness criteria. *Personnel Psychology* 61 (2), S. 273-307.

Lewis, M. W. (2000). Exploring paradox: Toward a more comprehensive guide. *Academy of Management Review* 25 (4), S. 760-776.

Lewis, M. W. and Smith, W. K. (2022). Reflections on the 2021 Amr Decade Award: Navigating Paradox Is Paradoxical. *Academy of Management Review* 47 (4), S. 528-548.

Lindberg, M. B., Markard, J. and Andersen, A. D. (2019). Policies, actors and sustainability transition pathways: A study of the EU's energy policy mix. *Research Policy* 48 (10).

Lindsjørn, Y., Sjøberg, D. I., Dingsøyr, T., Bergersen, G. R. and Dybå, T. (2016). Teamwork quality and project success in software development: A survey of agile development teams. *Journal of Systems and Software* 122, S. 274-286.

Lomberg, C., Urbig, D., Stockmann, C., Marino, L. D. and Dickson, P. H. (2017). Entrepreneurial Orientation: The Dimensions' Shared Effects in Explaining Firm Performance. *Entrepreneurship Theory and Practice* 41 (6), S. 973-998.

Lumpkin, G. T. and Dess, G. G. (1996). Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review* 21 (1), S. 135-172.

Luo, X. R., Wang, D. Q. and Zhang, J. J. (2017). Whose Call to Answer: Institutional Complexity and Firms' Csr Reporting. *Academy of Management Journal* 60 (1), S. 321-344.

Ma, J., Harstvedt, J. D., Jaradat, R. and Smith, B. (2020). Sustainability driven multi-criteria project portfolio selection under uncertain decision-making environment. *Computers & Industrial Engineering* 140.

Ma, J. F., Harstvedt, J. D., Jaradat, R. and Smith, B. (2020). Sustainability driven multi-criteria project portfolio selection under uncertain decision-making environment. *Computers & Industrial Engineering* 140.

March, J. G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science* 2 (1), S. 71-87.

Markard, J., Raven, R. and Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy* 41 (6), S. 955-967.

Marnewick, C. and Marnewick, A. L. (2019). The Demands of Industry 4.0 on Project Teams. *IEEE Transactions on Engineering Management*, S. 1-9.

Marquis, C., Toffel, M. W. and Zhou, Y. H. (2016). Scrutiny, Norms, and Selective Disclosure: A Global Study of Greenwashing. *Organization Science* 27 (2), S. 483-504.

Marshall, A. (1890). Principles of Economics. London Macmillan and Co.

Martinsuo, M. (2013). Project portfolio management in practice and in context. *International Journal of Project Management* 31 (6), S. 794-803.

Martinsuo, M. and Geraldi, J. (2020). Management of project portfolios: Relationships of project portfolios with their contexts. *International Journal of Project Management* 38 (7), S. 441-453.

Martinsuo, M. and Killen, C. P. (2014). Value Management in Project Portfolios: Identifying and Assessing Strategic Value. *Project Management Journal* 45 (5), S. 56-70.

Martinsuo, M., Korhonen, T. and Laine, T. (2014). Identifying, framing and managing uncertainties in project portfolios. *International Journal of Project Management* 32 (5), S. 732-746.

Martinsuo, M. and Lehtonen, P. (2007). Role of single-project management in achieving portfolio management efficiency. *International Journal of Project Management* 25 (1), S. 56-65.

Marzi, G., Ciampi, F., Dalli, D. and Dabic, M. (2021). New Product Development During the Last Ten Years: The Ongoing Debate and Future Avenues. *Ieee Transactions on Engineering Management* 68 (1), S. 330-344.

Mathias, B. D., McCann, B. T. and Whitman, D. S. (2020). A meta-analysis of agglomeration and venture performance: Firm-level evidence. *Strategic Entrepreneurship Journal* 15 (3), S. 430-453.

Mathieu, J., Maynard, M. T., Rapp, T. and Gilson, L. (2008). Team effectiveness 1997-2007: A review of recent advancements and a glimpse into the future. *Journal of Management* 34 (3), S. 410-476.

McCann, B. T. and Folta, T. B. (2011). Performance differentials within geographic clusters. *Journal of Business Venturing* 26 (1), S. 104-123.

McCrory, G., Schapke, N., Holmen, J. and Holmberg, J. (2020). Sustainability-oriented labs in real-world contexts: An exploratory review. *Journal of Cleaner Production* 277.

McNally, R. C., Durmusoglu, S. S. and Calantone, R. J. (2013). New Product Portfolio Management Decisions: Antecedents and Consequences. *Journal of Product Innovation Management* 30 (2), S. 245-261.

Melo, J. C. F. d., Salerno, M. S., Freitas, J. S., Bagno, R. B. and Brasil, V. C. (2021). Reprint of: From open innovation projects to open innovation project management capabilities: A process-based approach. *International Journal of Project Management* 39 (2), S. 170-182.

Meskendahl, S. (2010). The influence of business strategy on project portfolio management and its success - A conceptual framework. *International Journal of Project Management* 28 (8), S. 807-817.

Miller, D. (1983). The Correlates of Entrepreneurship in Three Types of Firms. *Management Science* 29 (7), S. 770-791.

Miron-Spektor, E., Erez, M. and Naveh, E. (2011). The Effect of Conformist and Attentive-To-Detail Members on Team Innovation: Reconciling the Innovation Paradox. *Academy of Management Journal* 54 (4), S. 740-760.

Miron-Spektor, E., Ingram, A., Keller, J., Smith, W. K. and Lewis, M. W. (2018). Microfoundations of Organizational Paradox: The Problem Is How We Think About the Problem. *Academy of Management Journal* 61 (1), S. 26-45.

Moe, N. B., Dingsoyr, T. and Dyba, T. (2010). A teamwork model for understanding an agile team: A case study of a Scrum project. *Information and Software Technology* 52 (5), S. 480-491.

Moe, N. B., Dingsøyr, T. and Dybå, T. (2008). Understanding self-organizing teams in agile software development. 19th Australian Conference on Software Engineering: IEEE.

Müller, R., Martinsuo, M. and Blomquist, T. (2008). Project Portfolio Control and Portfolio Management Performance in Different Contexts. *Project Management Journal* 39 (3), S. 28-42.

Murillo-Luna, J. L., Garcés-Ayerbe, C. and Rivera-Torres, P. (2008). Why do patterns of environmental response differ? A stakeholders' pressure approach. *Strategic Management Journal* 29 (11), S. 1225-1240.

Muruganandan, K., Davies, A., Denicol, J. and Whyte, J. (2022). The dynamics of systems integration: Balancing stability and change on London's Crossrail project. *International Journal of Project Management* 40 (6), S. 608-623.

Nagel, R., Preiss, R. and Goldman, K. (1995). Agile competitors and virtual organizations: strategies for enriching the customer. New York: Van Nostrand Reinhold.

Neugebauer, F., Figge, F. and Hahn, T. (2016). Planned or Emergent Strategy Making? Exploring the Formation of Corporate Sustainability Strategies. *Business Strategy and the Environment* 25 (5), S. 323-336.

Nevens, F., Frantzeskaki, N., Gorissen, L. and Loorbach, D. (2013). Urban Transition Labs: co-creating transformative action for sustainable cities. *Journal of Cleaner Production* 50, S. 111-122.

Nguyen, N. M., Killen, C. P., Kock, A. and Gemunden, H. G. (2018). The use of effectuation in projects: The influence of business case control, portfolio monitoring intensity and project innovativeness. *International Journal of Project Management* 36 (8), S. 1054-1067.

Nidumolu, R., Prahalad, C. K. and Rangaswami, M. R. (2009). Why Sustainability Is Now the Key Driver of Innovation. *Harvard Business Review* 87 (9), S. 56-+.

Orlando, M. J., Verba, M. and Weiler, S. (2019). Universities, Agglomeration, and Regional Innovation. *Review of Regional Studies* 49 (3), S. 407-427.

Overby, E., Bharadwaj, A. and Sambamurthy, V. (2006). Enterprise agility and the enabling role of information technology. *European Journal of Information Systems* 15 (2), S. 120-131.

Palanski, M. E., Kahai, S. S. and Yammarino, F. J. (2010). Team Virtues and Performance: An Examination of Transparency, Behavioral Integrity, and Trust. *Journal of Business Ethics* 99 (2), S. 201-216.

Pallot, M. (2009). The living lab approach: A user centred open innovation ecosystem. *Webergence Blog* 2010.

Paparoidamis, N. G., Tran, T. T. H., Leonidou, L. C. and Zeriti, A. (2019). Being Innovative While Being Green: An Experimental Inquiry into How Consumers Respond to Eco-Innovative Product Designs. *Journal of Product Innovation Management* 36 (6), S. 824-847.

Park, Y., El Sawy, O. A. and Fiss, P. C. (2017). The Role of Business Intelligence and Communication Technologies in Organizational Agility: A Configurational Approach. *Journal of the Association for Information Systems* 18 (9), S. 648-686.

Petit, Y. (2012). Project portfolios in dynamic environments: Organizing for uncertainty. *International Journal of Project Management* 30 (5), S. 539-553.

Pinto, M. B., Pinto, J. K. and Prescott, J. E. (1993). Antecedents and Consequences of Project Team Cross-Functional Cooperation. *Management Science* 39 (10), S. 1281-1297.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y. and Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *J Appl Psychol* 88 (5), S. 879-903.

Porter, M. E. (1998). Clusters and the new economics of competition. Boston: Harvard Business Review.

Pradies, C. (2023). With Head and Heart: How Emotions Shape Paradox Navigation in Veterinary Work. *Academy of Management Journal* 66 (2), S. 521-552.

Priem, R. L. and Butler, J. E. (2001). Is the Resource-Based "View" a Useful Perspective for Strategic Management Research? *Academy of Management Review* 26 (1), S. 22-40.

Putnam, L. L., Fairhurst, G. T. and Banghart, S. (2016). Contradictions, Dialectics, and Paradoxes in Organizations: A Constitutive Approach†. *The Academy of Management Annals* 10 (1), S. 65-171.

Queiroz, M., Tallon, P. P., Sharma, R. and Coltman, T. (2018). The role of IT application orchestration capability in improving agility and performance. *Journal of Strategic Information Systems* 27 (1), S. 4-21.

Rauch, A., Wiklund, J., Lumpkin, G. and Frese, M. (2009). Entrepreneurial Orientation and Business Performance: An Assessment of Past Research and Suggestions for the Future. *Entrepreneurship Theory and Practice* 33 (3), S. 761-787.

Roberts, N. and Grover, V. (2014). Leveraging Information Technology Infrastructure to Facilitate a Firm's Customer Agility and Competitive Activity: An Empirical Investigation. *Journal of Management Information Systems* 28 (4), S. 231-270.

Rosenbusch, N., Rauch, A. and Bausch, A. (2011). The Mediating Role of Entrepreneurial Orientation in the Task Environment–Performance Relationship. *Journal of Management* 39 (3), S. 633-659.

Roth, T., Spieth, P. and Lange, D. (2019). Managerial Political Behavior in Innovation Portfolio Management: A Sensegiving and Sensebreaking Process. *Journal of Product Innovation Management* 36 (5), S. 534-559.

Rothaermel, F. T. and Hess, A. M. (2007). Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. *Organization Science* 18 (6), S. 898-921.

Roxas, B. and Coetzer, A. (2012). Institutional Environment, Managerial Attitudes and Environmental Sustainability Orientation of Small Firms. *Journal of Business Ethics* 111 (4), S. 461-476.

Sabini, L., Muzio, D. and Alderman, N. (2017): Integrating sustainability into project management practices: the perspective of professional institutions. International Research Network on Organizing by Projects (IRNOP) 2017.

Sabini, L., Muzio, D. and Alderman, N. (2019). 25 years of 'sustainable projects'. What we know and what the literature says. *International Journal of Project Management* 37 (6), S. 820-838.

Salomo, S., Talke, K. and Strecker, N. (2008). Innovation field orientation and its effect on innovativeness and firm performance. *Journal of Product Innovation Management* 25 (6), S. 560-576.

Sambamurthy, V., Bharadwaj, A. and Grover, V. (2003). Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *Mis Quarterly* 27 (2), S. 237-263.

Sánchez, M. A. (2015). Integrating sustainability issues into project management. *Journal of Cleaner Production* 96, S. 319-330.

Savelsbergh, C. M. J. H., Havermans, L. A. and Storm, P. (2016). Development paths of project managers: What and how do project managers learn from their experiences? *International Journal of Project Management* 34 (4), S. 559-569.

Schad, J., Lewis, M. W., Raisch, S. and Smith, W. K. (2016). Paradox Research in Management Science: Looking Back to Move Forward. *Academy of Management Annals* 10 (1), S. 5-64.

Schilke, O. (2014). On the contingent value of dynamic capabilities for competitive advantage: The nonlinear moderating effect of environmental dynamism. *Strategic Management Journal* 35 (2), S. 179-203.

Schilke, O., Hu, S. and Helfat, C. E. (2018). Quo Vadis, Dynamic Capabilities? A Content-Analytic Review of the Current State of Knowledge and Recommendations for Future Research. *Academy of Management Annals* 12 (1), S. 390-439.

Schlegel, T., Pfister, C., Harhoff, D. and Backes-Gellner, U. (2021). Innovation effects of universities of applied sciences: an assessment of regional heterogeneity. *The Journal of Technology Transfer* 47 (1), S. 63-118.

Schrage, S. and Rasche, A. (2021). Inter-Organizational Paradox Management: How national business systems affect responses to paradox along a global value chain. *Organization Studies* 43 (4), S. 547-571.

Schultz, C., Salomo, S., de Brentani, U. and Kleinschmidt, E. J. (2013). How Formal Control Influences Decision-Making Clarity and Innovation Performance. *Journal of Product Innovation Management* 30 (3), S. 430-447.

Schultz, C., Salomo, S. and Talke, K. (2013). Measuring New Product Portfolio Innovativeness: How Differences in Scale Width and Evaluator Perspectives Affect its Relationship with Performance. *Journal of Product Innovation Management* 30, S. 93-109.

Schwaber, K. and Beedle, M. (2002). Agile software development with Scrum. Prentice Hall Upper Saddle River.

Schweiger, S. A., Stettler, T. R., Baldauf, A. and Zamudio, C. (2019). The complementarity of strategic orientations: A meta-analytic synthesis and theory extension. *Strategic Management Journal* 40 (11), S. 1822-1851.

Scott, S. G. and Bruce, R. A. (1994). Determinants of Innovative Behavior - a Path Model of Individual Innovation in the Workplace. *Academy of Management Journal* 37 (3), S. 580-607.

Serrador, P. and Pinto, J. K. (2015). Does Agile work?—A quantitative analysis of agile project success. *International Journal of Project Management* 33 (5), S. 1040-1051.

Sethi, R. and Iqbal, Z. (2008). Stage-Gate controls, learning failure, and adverse effect on novel new products. *Journal of Marketing* 72 (1), S. 118-134.

Shenhar, A. J. (2001). One Size Does Not Fit All Projects: Exploring Classical Contingency Domains. *Management Science* 47 (3), S. 394-414.

Shenhar, A. J., Dvir, D., Levy, O. and Maltz, A. C. (2001). Project success: A multidimensional strategic concept. *Long Range Planning* 34 (6), S. 699-725.

Si, H., Kavadias, S. and Loch, C. (2022). Managing innovation portfolios: From project selection to portfolio design. *Production and Operations Management* 31 (12), S. 4572-4588.

Slawinski, N. and Bansal, P. (2015). Short on Time: Intertemporal Tensions in Business Sustainability. *Organization Science* 26 (2), S. 531-549.

Smith, W. K. (2014). Dynamic Decision Making: A Model of Senior Leaders Managing Strategic Paradoxes. *Academy of Management Journal* 57 (6), S. 1592-1623.

Smith, W. K. and Lewis, M. W. (2011). Toward a Theory of Paradox: A Dynamic Equilibrium Model of Organizing. *Academy of Management Review* 36 (2), S. 381-403.

Smith, W. K. and Lewis, M. W. (2022). Both/and thinking: Embracing creative tensions to solve your toughest problems. Harvard Business Review Press.

Söderlund, J. (2011). Competence Dynamics and Learning Processes in Project-Based Firms: Shifting, Adapting and Leveraging. *International Journal of Innovation Management* 12 (01), S. 41-67.

Soderstrom, S. B. and Weber, K. (2019). Organizational Structure from Interaction: Evidence from Corporate Sustainability Efforts. *Administrative Science Quarterly* 65 (1), S. 226-271.

Spanjol, J., Muhlmeier, S. and Tomczak, T. (2012). Strategic Orientation and Product Innovation: Exploring a Decompositional Approach. *Journal of Product Innovation Management* 29 (6), S. 967-985.

Spanjol, J., Qualls, W. J. and Rosa, J. A. (2011). How Many and What Kind? The Role of Strategic Orientation in New Product Ideation*. *Journal of Product Innovation Management* 28 (2), S. 236-250.

Steen, J., Ford, J. A. and Verreynne, M. L. (2021). A Dynamic Capabilities Model of Innovation in Large Interfirm Projects. *Project Management Journal* 52 (5), S. 488-503.

Stettina, C. J. and Horz, J. (2015). Agile portfolio management: An empirical perspective on the practice in use. *International Journal of Project Management* 33 (1), S. 140-152.

Strode, D. E., Sharp, H., Barroca, L., Gregory, P. and Taylor, K. (2022). Tensions in Organizations Transforming to Agility. *IEEE Transactions on Engineering Management* 69 (6), S. 3572-3583.

Sweetman, R. and Conboy, K. (2018). Portfolios of Agile Projects A Complex Adaptive Systems' Agent Perspective. *Project Management Journal* 49 (6), S. 18-38.

Talke, K., Salomo, S. and Kock, A. (2011). Top Management Team Diversity and Strategic Innovation Orientation: The Relationship and Consequences for Innovativeness and Performance. *Journal of Product Innovation Management* 28 (6), S. 819-832.

Tallon, P. P., Queiroz, M., Coltman, T. and Sharma, R. (2019). Information technology and the search for organizational agility: A systematic review with future research possibilities. *Journal of Strategic Information Systems* 28 (2), S. 218-237.

Tanriverdi, H. and Venkatraman, N. (2005). Knowledge relatedness and the performance of multibusiness firms. *Strategic Management Journal* 26 (2), S. 97-119.

Teece, D., Peteraf, M. and Leih, S. (2016). Dynamic Capabilities and Organizational Agility: Risk, Uncertainty, and Strategy in the Innovation Economy. *California Management Review* 58 (4), S. 13-35.

Teece, D. J. (1986). Profiting from Technological Innovation - Implications for Integration, Collaboration, Licensing and Public-Policy. *Research Policy* 15 (6), S. 285-305.

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal* 28 (13), S. 1319-1350.

Teece, D. J., Pisano, G. and Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal* 18 (7), S. 509-533.

Teller, J. and Kock, A. (2013). An empirical investigation on how portfolio risk management influences project portfolio success. *International Journal of Project Management* 31 (6), S. 817-829.

Teller, J., Kock, A. and Gemünden, H. G. (2014). Risk Management in Project Portfolios is More than Managing Project Risks: A Contingency Perspective on Risk Management. *Project Management Journal* 45 (4), S. 67-80.

Teller, J., Unger, B. N., Kock, A. and Gemunden, H. G. (2012). Formalization of project portfolio management: The moderating role of project portfolio complexity. *International Journal of Project Management* 30 (5), S. 596-607.

Thummadi, B. V. and Paruchuri, S. (2022). Presence of Location-Based Agglomeration Effects in Open Source Communities: An Empirical Test on Github. *Academy of Management Discoveries* 8 (2), S. 274-297.

Tschang, F. T. (2007). Balancing the Tensions Between Rationalization and Creativity in the Video Games Industry. *Organization Science* 18 (6), S. 989-1005.

Turner, J. R. and Müller, R. (2003). On the nature of the project as a temporary organization. *International Journal of Project Management* 21 (1), S. 1-8.

Tushman, M. L. and O'Reilly, C. A. (1996). Ambidextrous Organizations: Managing Evolutionary and Revolutionary Change. *California Management Review* 38 (4), S. 8-29.

Unger, B. N., Kock, A., Gemunden, H. G. and Jonas, D. (2012). Enforcing strategic fit of project portfolios by project termination: An empirical study on senior management involvement. *International Journal of Project Management* 30 (6), S. 675-685.

Uotila, J., Maula, M., Keil, T. and Zahra, S. A. (2009). Exploration, exploitation, and financial performance: analysis of S&P 500 corporations. *Strategic Management Journal* 30 (2), S. 221-231.

Vähäniitty, J. (2012). Towards agile product and portfolio management. Helsinki: School of Science.

van Bommel, K. (2018). Managing tensions in sustainable business models: Exploring instrumental and integrative strategies. *Journal of Cleaner Production* 196, S. 829-841.

Van der Byl, C. A. and Slawinski, N. (2015). Embracing Tensions in Corporate Sustainability. *Organization & Environment* 28 (1), S. 54-79.

van Knippenberg, D., De Dreu, C. K. and Homan, A. C. (2004). Work group diversity and group performance: an integrative model and research agenda. *J Appl Psychol* 89 (6), S. 1008-1022.

Verzijlbergh, R. A., De Vries, L. J., Dijkema, G. P. J. and Herder, P. M. (2017). Institutional challenges caused by the integration of renewable energy sources in the European electricity sector. *Renewable & Sustainable Energy Reviews* 75, S. 660-667.

Villamil, C. and Hallstedt, S. (2020). Sustainabilty integration in product portfolio for sustainable development: Findings from the industry. *Business Strategy and the Environment* 30 (1), S. 388-403.

Villamil, C. and Hallstedt, S. I. (2018). Sustainability Product Portfolio: A Review. *European Journal of Sustainable Development* 7 (4), S. 146-158.

Villamil, C., Schulte, J. and Hallstedt, S. (2022). Sustainability risk and portfolio management-A strategic scenario method for sustainable product development. *Business Strategy and the Environment* 31 (3), S. 1042-1057.

Voytenko, Y., McCormick, K., Evans, J. and Schliwa, G. (2016). Urban living labs for sustainability and low carbon cities in Europe: towards a research agenda. *Journal of Cleaner Production* 123, S. 45-54.

Weiland, S., Bleicher, A., Polzin, C., Rauschmayer, F. and Rode, J. (2017). The nature of experiments for sustainability transformations: A search for common ground. *Journal of Cleaner Production* 169, S. 30-38.

Weiss, M., Hoegl, M. and Gibbert, M. (2011). Making Virtue of Necessity: The Role of Team Climate for Innovation in Resource-Constrained Innovation Projects. *Journal of Product Innovation Management* 28 (s1), S. 196-207.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal* 5 (2), S. 171-180.

Wiesche, M. (2021). Interruptions in Agile Software Development Teams. *Project Management Journal* 52 (2), S. 210-222.

Wijethilake, C. and Lama, T. (2019). Sustainability core values and sustainability risk management: Moderating effects of top management commitment and stakeholder pressure. *Business Strategy and the Environment* 28 (1), S. 143-154.

Wilden, R., Gudergan, S. P., Nielsen, B. B. and Lings, I. (2013). Dynamic Capabilities and Performance: Strategy, Structure and Environment. *Long Range Planning* 46 (1-2), S. 72-96.

Williams, L. (2012). What Agile Teams Think of Agile Principles. *Communications of the Acm* 55 (4), S. 71-76.

Yin, R. K. (1994). Discovering the Future of the Case-Study Method in Evaluation Research. *Evaluation Practice* 15 (3), S. 283-290.

Zhao, M., Yang, J., Shu, C. and Liu, J. (2021). Sustainability orientation, the adoption of 3D printing technologies, and new product performance: A cross-institutional study of American and Indian firms. *Technovation* 101.

Zhou, K. Z., Yim, C. K. and Tse, D. K. (2005). The Effects of Strategic Orientations on Technology- and Market-Based Breakthrough Innovations. *Journal of Marketing* 69 (2), S. 42-60.

Zwikael, O. and Meredith, J. (2021). Evaluating the Success of a Project and the Performance of Its Leaders. *Ieee Transactions on Engineering Management* 68 (6), S. 1745-1757.

Declaration of Authorship

The dissertation is provided by me with a list of all sources used. I declare that I have written the thesis on my own - apart from the help explicitly mentioned in it.

The thesis has not been published anywhere else nor presented to any other examination board.

Die Dissertation ist von mir mit einem Verzeichnis aller benutzten Quellen versehen. Ich erkläre, dass ich die Arbeit – abgesehen von den in ihr ausdrücklich genannten Hilfen – selbstständig verfasst habe.

Die Arbeit wurde bisher weder einer anderen Prüfungsbehörde vorgelegt noch veröffentlicht.

Jadena Bechtel

_____ _____

(Place/ Ort) (Date/ Datum)

_____ (Signature/ Unterschrift)