Managing Coopetitive R&D and Innovation: A Project-Level Perspective

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UiA University of Agder

Doctoral Dissertations at the University of Agder 345

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‘Go as far as you can see; when you get there, you'll be able to see farther.’
John Pierpont Morgan

This PhD was cotutelle based, so the story has equally important Norwegian and Australian parts. Three and a half years ago, I came to Norway for the first time. Starting a new stage in life, I came to stay and pursue this PhD journey. ‘Velkommen til Norge’ was the first thing heard, and this country, so often labelled as ‘cold,’ has been a delightful – and warm in the ways that matter – home for me since my arrival. Its unique nature, admirable work and life culture, trust-based society and efficient and smooth procedures are some of the major reasons for falling in love with Norway.

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Empowered by this amazing experience and looking forward to the new chapter in my personal and professional life,

Sanja Smiljić

July 2021

Abstract

High technological convergence, shorter product lifecycles and rising research and development (R&D) costs have increased R&D and innovation collaboration between competitors in mature manufacturing industries. Scholars have argued that sharing knowledge and complementary resources can help competitors reduce costs and risks, stimulate innovation, enter new markets and develop new products. Collaboration between competitors, however, poses a high risk of technology imitation, knowledge leaks and weakened market position. Furthermore, research often downplays the role of other partners in many coopetitive R&D collaborations, although the presence of research institutions, suppliers or customers may simultaneously enhance benefits and increase the complexity and challenges of managing coopetition. Therefore, while the number of established R&D and innovation collaborations between competitors in mature manufacturing industries has grown, many such efforts fail, so more knowledge about managing their complex interactions is of both academic and practical relevance.

Most previous research on coopetition for R&D and innovation examines emerging industries, and scholars have tended to study science- and market-based R&D and innovation collaborations separately. This dissertation seeks to reveal how coopetitive R&D and innovation projects in mature manufacturing industries can be managed. Using a qualitative research design and an embedded case study of six coopetitive R&D projects that also include non-competitive partners, three qualitative papers were produced. The empirical data consist of 48 interviews with high- and middle-level managers from competing companies, project managers, cluster managers and employees from universities and research centres involved in the sampled projects.

The findings demonstrate how customers and research partners mitigate coopetitive risks and enhance the willingness of competing companies to accept the invitation to join coopetitive R&D and innovation projects in mature industries. They also identify the specific role of business clusters in enabling collaboration in the pre-project phase and research partners in balancing coopetition during the pre-project and project implementation phases. Finally, this dissertation highlights the intensity of intra- and inter-organisational tensions in the pre-project and implementation phases, respectively, and explains successful management using paradox theory. By going past the competitor-to-competitor dyad and the focal-actor perspective, this dissertation contributes to coopetition, innovation and R&D research and provides

insights for practitioners seeking to establish and manage coopetitive R&D and innovation projects in mature manufacturing industries.

Keywords: Coopetition; Innovation; R&D Collaboration; Mature industries; Manufacturing; Coopetitive innovation projects; Non-competitive partners; Tensions; Paradox theory

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Dissemination of Research Output

This dissertation is based on three full papers either published or under review at top-tier journals; all three papers are included in full in Part II.

Papers included in this dissertation and authors' contributions

Paper 1: Smiljic, S, Aas, TH & Mention, AL, 'Is joining the party worth it? Insights from coopetitive R&D projects'; submitted and under review at the peer-reviewed journal *R&D Management*. An earlier version of the paper was presented at the *R&D Management* Conference in Paris, France in June 2019.

The first author, Sanja Smiljic, expected contribution includes conceptualisation, methodology, formal analysis, investigation, writing – original draft, writing – review and editing, visualisation and project administration. Estimated contribution 80%. The second author, Tor Helge Aas, expected contributions include conceptualisation, writing – review and editing, visualisation and supervision. Estimated contribution 10%. The third author, Anne-Laure Mention, expected contribution includes conceptualisation, writing-review and editing, resources and supervision. Estimated contribution 10%.

Paper 2: Smiljic, S, Aas, TH & Mention, AL, 'Coopetitive tensions across project phases: a paradox perspective'; under second-round review at the peer-reviewed journal *Industrial Marketing Management*.

The first author, Sanja Smiljic, expected contribution includes conceptualisation, methodology, formal analysis, investigation, writing – original draft, writing – review and editing, visualisation and project administration. Estimated contribution 70%. The second author, Tor Helge Aas, expected contribution includes conceptualisation, writing – review and editing, visualisation and supervision. Estimated contribution 15%. The third author, Anne-Laure Mention, expected contribution includes conceptualisation, writing-review and editing, resources and supervision. Estimated contribution 15%.

Paper 3: Smiljic, S, 'Beyond the dyad: role of non-competitive partners in coopetitive R&D projects', *International Journal of Innovation Management*, vol. 24, no. 8, https://doi.org/10.1142/S136391962040006X

This is a sole-authored paper. An earlier version of this paper was accepted and presented at the 6th Annual World Open Innovation Conference in Rome in December 2019 and an online ISPIM Conference in June 2020.

Part I: Introduction to Doctoral Dissertation

1 Introduction

In today's rapidly changing and unstable business environment companies increasingly engage in collaborations for innovation to use internal and external knowledge and accelerate their innovation activities (West & Bogers 2014). While Industry 4.0 and digitalisation trends are influencing a wide range of various industries, the World Economic Forum (n.d.), for instance, has highlighted the crucial importance of partnerships for stimulating innovation, efficiency, sustainability and addressing digitalisation challenges in manufacturing industries. The economic importance of manufacturing industries is high in numerous countries. In the European Union, for instance, two million enterprises were classified as manufacturers in 2018, providing jobs to 29.9 million people and generating €1,944 billion in added value (European Commission 2021). Manufacturing is of particular importance for large exporters such as Japan, China, Germany and the United States. Notably, although the manufacturing sector accounts for only 8% of the US workforce and 11% of its gross domestic product (GDP), it is responsible for 35% of productivity growth, 60% of exports and 70% of public spending (Manyika et al. 2021). While 16 different manufacturing industries in the United States contribute to this dramatic impact, one of Germany's most important manufacturing sectors is the automotive industry, which in 2019 contributed 5% of German GDP, was responsible for 24% of total domestic industry revenues and employed around 833,000 people, with an export turnover of €282.4 billion. In 2019, 37% of premium car production worldwide came from Germany, and a third of global automotive research and development (R&D) spending was invested by German enterprises (Germany Trade & Invest 2020).

Different kinds of manufacturing industries have been recognised as both the fastest growing and most rapidly declining industries over the last two decades. For instance, the average annual increase in manufacturing at the EU level was 0.4% between 2000 and 2020, but there were large variations across sectors. The economic and financial crisis caused a sharp decline of 8.9% in 2008 and 2009 and even before manufacturing industries recovered, the COVID-19 crisis caused another 8.5% decline in 2020 (Eurostat 2021b). The pandemic was also reflected in an employment crisis, supply chain interruptions and the collapse of many sales

markets (DEStatis 2021). The pace of recovery varies between country and type of manufacturing industries (Eurostat 2021a), and numerous measures have been implemented at the company and inter-organisational levels to enhance the recovery process. The Organisation for Economic Cooperation and Development (OECD 2020), for instance, has noted the emergence of two types of cooperation between competing companies during the COVID-19 crisis: 1) preserving short-term manufacturing and the functioning of supply and distribution chains, and 2) creating new products in response to the crisis, particularly among pharmaceutical industries.

The literature also shows the potential of cooperation between competitors to enhance innovativeness (Bacon, Williams & Davies 2020; Bengtsson et al. 2016; Cygler et al. 2018) due to the complementarities that often exist between such companies (Mention 2011). Competing companies have complementary knowledge and resources, face common market conditions and customer needs and often confront the same challenges and uncertainties (Bacon, Williams & Davies 2020; Bouncken et al. 2015). While companies typically innovate through R&D projects (Cassiman, Di Guardo & Valentini 2010), current economic conditions featuring high technological convergence, shorter product lifecycles and rising R&D costs have increased R&D and innovation collaboration between competitors in manufacturing industries (Pereira, Leitão & Devezas 2017; Ritala & Sainio 2014; Ritala et al. 2017). The relationship between competitors is, however, often complex and can carry a high risk of technology imitation, knowledge leaks and undermining existing market position (Bouncken & Fredrich 2016; Cygler & Sroka 2017; De Araujo & Franco 2017; Le Roy, Robert & Lasch 2016; Tidström & Hagberg-Andersson 2012). The management of coopetitive collaborations for R&D and innovation is therefore recognised as particularly challenging and has been addressed in an increasing number of studies (Belderbos, Carree & Lokshin 2004; Carayannis & Alexander 2004; Cassiman & Veugelers 2002; Chowdhury, Gruber & Zolkiewski 2016; Fernandez & Chiambaretto 2016; Miotti & Sachwald 2003; Ritala & Tidström 2014; Segbotangni, Le Roy & Fernandez 2019a; Tether 2002; Tidström & Hagberg-Andersson 2012). Partner selection and management of tensions have been recognised as critical factors for the success of coopetitive collaborations (Fernandez, Le Roy & Gnyawali 2014; Kraus et al. 2018).

Scholars have reported divergent findings about the benefits and influence of coopetition on innovation performance. Some have identified positive effects (Bouncken & Fredrich 2012; Bouncken & Kraus 2013; Lassen & Laugen 2017; Ritala & Hurmelinna-Laukkanen 2013), others have revealed negative effects (Bouncken & Kraus 2013; Mention 2011; Nieto & Santamaría 2007; Ritala & Sainio 2014), and still others claim the overall effects are neutral (Santamaría & Surroca 2011). Similarly, even though coopetitive collaborations have become increasingly important in response to increased technological pressures and change (Onufrey & Bergek 2020), coopetitive R&D and innovation collaborations undertaken by manufacturers have proven both successful and unsuccessful. For instance, to counter the COVID-19 crisis, inter-country cooperation involving competing pharmaceutical companies and competing manufacturers of medical equipment from the United States, China and Germany was implemented in 2020 to speed up the development and delivery of COVID-19 tests and vaccines (Crick & Crick 2020). There are also numerous examples of coopetitive collaborations in manufacturing industries at the inter-organisational level. For instance, Samsung and Sony, well-known competitors in LCD TV markets, used their advantages of technological and marketing resources and capabilities to jointly develop LCD panels for TV sets (Ritala & Sainio 2014). General Motors and Toyota worked together to develop fuel cell-powered cars, and Siemens and Philips jointly developed semiconductors (Hamel, Doz & Prahalad 1989). At the same time, several collaborations have failed. For instance, Ford and Toyota established a collaboration in 2011 (Bunkley 2011) that sought to jointly develop a gas-electric hybrid fuel system for trucks and sports vehicles; the initiative was terminated by Ford in 2013 (Agence France-Presse 2013). Another example is the long-term strategic collaboration established in July 2019 between BMW and Mercedes-Benz (Redfern 2019) that aimed at the joint development of new-generation technologies for driver assistance systems, automated driving and automated parking that would result in self-driving cars by 2024. After less than a year, the partnership ended (BMW 2020). Some of the reasons the companies cited were much higher costs and the greater complexity of the platform than originally anticipated.

These examples, on the one hand, confirm the need for and importance of collaboration between competitors in manufacturing industries, and, on the other, reveal the difficulties involved in managing and sustaining these collaborations.

They also raise the question of why some collaborations succeed and others fail, even in the same industry. Certain characteristics of manufacturing industries need to be taken into consideration. For instance, scholars have indicated the lower benefits of coopetition in manufacturing than in other industries (Nieto & Santamaría 2007). Furthermore, technology, as a source of core competitive advantage in manufacturing industries, may be particularly vulnerable to coopetitive dynamics and changing roles during coopetitive relationships (Tidström & Rajala 2016), while internal innovation processes and resistance to external R&D may limit co-innovation capacities among manufacturing industries (Pereira, Leitão & Devezas 2017). Furthermore, scholars distinguish between emergent and mature manufacturing industries. Greater industrial maturity, combined with increased costs and shrinking markets, stimulate even more intense competition between companies (Mathias et al. 2018; Tidström & Rajala 2016). Companies in mature industries tend to rely more on employees' tacit knowledge and may face difficulties incorporating knowledge from external actors (Chiaroni, Chiesa & Frattini 2010; Ciravegna & Maielli 2011). Under these conditions, maintaining sustainable coopetitive innovation relationships in the long run becomes particularly difficult.

Next, while we have comprehensive knowledge about innovation networks and alliances, especially from the firm perspective, scholars claim some conflicting and even contradictory findings may result from adopting solely the firm perspective (Du, Leten & Vanhaverbeke 2014; Keinz et al. 2021). Different innovation projects may be of different strategic importance to the company, lead to different types of innovation and require different types of knowledge and collaboration partners (Cassiman, Di Guardo & Valentini 2010; Kim, Kim & Lee 2015; Lee et al. 2019). Therefore, several scholars have sought deeper insights into innovation projects (e.g., Gurca et al. 2021; Markovic et al. 2021; West & Bogers 2017).

Lastly, while dyadic competitor-to-competitor relationships have been the primary focus of research in previous decades, scholars have recently started acknowledging the importance of complex multi-partner projects (Guertler & Sick 2021; Mishra, Chandrasekaran & MacCormack 2015; Rouyre & Fernandez 2019) that, in addition to multiple competitors, feature the presence of non-competitive partners that may enhance synergies and, at the same time, lead to coopetitive, organisational and managerial challenges (Barbic, Hidalgo & Cagliano 2016; Du

et al. 2020; Henttonen, Hurmelinna-Laukkanen & Ritala 2016; Ritala et al. 2017). Since the success of coopetitive R&D and innovation projects depends on the willingness of partners to collaborate and share knowledge and information (Geum et al. 2013), more knowledge of multi-partner collaborative projects is of both practical and academic relevance (Czakon & Czernek 2016; Tidström & Rajala 2016).

The overall goal of this dissertation is to provide novel theoretical insights into the establishment and management of multi-partner coopetitive R&D and innovation projects in mature manufacturing industries and knowledge of practical relevance for companies, project managers, researchers and other partners embarking on coopetitive R&D and innovation journeys. These companies may face structural, cultural and organisational challenges that can influence their relationships at the project level and the overall sustainability and success of any collaborations that are undertaken. This introduction to the dissertation includes a presentation of the research gaps, the study purpose and research questions, its structure, positioning and scope of the research.

1.1 Research gaps

By introducing the concept of open innovation (OI), Henry Chesbrough (2003) laid the foundation for exponential growth in research interest in innovation based on both internal and external knowledge, ideas and resources. Since the OI concept was developed, scholars have examined different types, motives and effects of OI partnerships (West & Bogers 2014). They distinguish between innovation in collaboration with market partners like suppliers and customers and innovation in collaboration with research partners like universities and research institutions (Du, Leten & Vanhaverbeke 2014). Among these types of collaborations for innovation, collaboration with competitors has received the least attention, although it has recently started to gain more interest in the OI research stream (Mention 2011).

The coopetition research stream, meanwhile, also explores cooperation between competitors for various non-innovation purposes such as joint distribution, sales and marketing (Chiambaretto & Dumez 2016; Pellegrin-Boucher, Le Roy & Gurău 2018) or innovation purposes, based on reduced costs and risks, sharing complementary knowledge and resources and penetration of new markets (Czakon, Mucha-Kuś & Sołtysik 2016; Roig-Tierno, Kraus & Cruz 2018; Trapp

et al. 2020). Therefore, cooperation between competitors for innovation is only one topic that has attracted significant attention from coopetition scholars (Devece, Ribeiro-Soriano & Palacios-Marqués 2019; Ritala & Sainio 2014). Broadly speaking, two main aspects have been considered success factors for coopetitive collaborations for innovation: partner selection and management of tensions (Fernandez & Chiambaretto 2016; Kraus et al. 2018). So far, coopetition research has largely been focused on dyadic relationships between competitors, and scholars have only evaluated the effects that other partners may have on competitor-to-competitor relationships to a limited degree (Rouyre & Fernandez 2019). Acknowledging this gap, some researchers have begun seeking better insights into the roles of other partners in the establishment and management of coopetitive relationships. Among a limited number of studies, some have explored coopetition along the value chain for different, not only innovation purposes. Several studies have noted the roles of third parties as initiators of deliberate coopetitive collaborations (Fernandez & Pierrot 2016). In this case, both public institutions and private clients may facilitate the emergence of coopetition strategies (Czakon & Czernek 2016; Depeyre & Dumez 2010; Eriksson 2008; Freel 2003). Fernandez and Le Roy (2015), on the other hand, found that public institutions might stimulate cooperation in emergent coopetitive collaborations, whereas if cooperation is not aligned with their private interests, private clients might stimulate competition. Third parties can also mitigate or increase tensions (Castaldo et al. 2010; Madhavan, Gnyawali & He 2004; Tidström, Ritala & Lainema 2018; Yami et al. 2010) or change the power structure in coopetitive relationships (Fernandez & Pierrot 2016), and scholars have sought deeper insights into the tensions related to other actors and their roles in managing coopetitive relationships (Chou & Zolkiewski 2017; Tidström 2014; Tidström, Ritala & Lainema 2018).

Similarly, when exploring R&D collaborations, scholars have mainly analysed efforts that involve either research or market partners like customers, suppliers and competitors (Du, Leten & Vanhaverbeke 2014). More attention has recently been directed towards multi-partner R&D collaborations that involve a variety of competitive and non-competitive partners and enrich the benefits of collaborations but at the same time bring a certain level of inter-organisational complexity (Ritala et al. 2017; Yang 2020). Coopetitive tensions, knowledge sharing and knowledge protection mechanisms have been recognised as some of the issues in multi-partner

R&D collaborations (Henttonen, Hurmelinna-Laukkanen & Ritala 2016; Rouyre & Fernandez 2019; Segbotangni, Le Roy & Fernandez 2019b; Yami & Nemeh 2014). Consequently, scholars have warned of the non-transferability of findings about dyadic R&D relationships and called for more research into complex multi-partner R&D collaborations (Ritala et al. 2017; Yang et al. 2020; Yang 2020). To the best of the author's knowledge, the complex interactions between competitive and non-competitive partners in coopetitive R&D and innovation collaborations have not received intensive scholarly attention, so the first gap this dissertation addresses is as follows: *1) the lack of the insights into the roles of non-competitive partners in coopetitive R&D and innovation collaborations and their influence on focal coopetitive relationships.*

While exploring business-to-business collaborations for innovation, previous OI and coopetition research have mainly focused on the firm level and innovation alliances, and it has been argued that there is a need for more research on those relationships and their management at the project level (Fernandez & Chiambaretto 2016; Gnyawali et al. 2016; West & Bogers 2017). Scholars argue that research at the project level may provide new insights that are not visible from the firm's perspective, since the same company may behave differently in different projects in terms of technology, resources and project management styles (Cassiman, Di Guardo & Valentini 2010). According to Culpan (2014), alliances for innovation and projects differ in terms of ties, goals and temporal perspectives. Innovation projects are oriented towards short-term relationships with loose ties and precise goals, while long-term alliance relationships involve stronger ties and aim to pool resources and capabilities. Today, companies typically innovate through R&D projects (Cassiman, Di Guardo & Valentini 2010). Different R&D partnerships may lead to different benefits, but not all are good for a company's innovation performance (Pippel 2015). Therefore, particular attention has to be paid to the specifics of OI projects that may demand different managing styles (Gurca et al. 2021).

When investigating coopetitive innovation projects, scholars have largely focused on the project implementation phase (Fernandez, Le Roy & Chiambaretto 2018), and we lack sufficient knowledge of the specifics of different project phases. This gap is concerning since the innovation management literature recognises that the characteristics of, for instance, the pre-project and project implementation phases can differ widely for innovation projects (Poskela &

Martinsuo 2009). The literature also emphasises the importance of the pre-project phase for shaping entire projects, influencing their quality and enhancing – or impeding – value creation (Edkins et al. 2013). Scholars caution that mistakes in the pre-project phase can diminish or even imperil a project's outcomes, performance and value generation and call for special attention to this phase and its management (Floricel, Michela & Piperca 2016). More recently, Czakon et al. (2020) indicated the need for more insights into changes in tensions and their manifestation during coopetition phases and the influence of coopetition tensions on project outcomes. Therefore, exploring the manifestation of tensions, as one of the main success factors, and their management across project phases may be particularly important. In response to the calls for more research noted above, the second gap this dissertation aims to address is *2) the lack of insights into coopetitive R&D and innovation projects and the management of different project phases.*

The literature also indicates that innovation practices and processes can vary in different phases of the industry lifecycle (Bodas Freitas, Argou Marques & de Paula Silva 2013; McGahan & Silverman 2001). While OI practices are well suited to accommodating innovation processes of companies in emerging industries (Chesbrough & Crowther 2006), companies in mature industries tend to rely more on closed innovation processes (Boscherini et al. 2012). Consequently, emerging high-tech industries have been recognised as early adopters of OI practices (Chesbrough & Crowther 2006), and most empirical studies are related to this context. When moving towards a more OI orientation, companies in mature industries often face challenges in transforming their internal practices to enable the incorporation of knowledge from external actors (Chiaroni, Chiesa & Frattini 2010; Ciravegna & Maielli 2011). Therefore, finding the appropriate balance between open and closed innovation practices in mature industries has been a matter of considerable debate in the academic literature (Caiazza 2015; Chiaroni, Chiesa & Frattini 2010). The context of mature industries has also been less deeply explored in the coopetition research stream and, in response to calls from several scholars who claim that coopetitive collaborations in this context may be more challenging with less visible benefits in advance and therefore less attractive for companies (e.g., Dosi & Nelson 2013; Jakobsen 2020; Mathias et al. 2018), the third research gap that this dissertation addresses is *3) the lack of insights into*

coopetitive collaborations for R&D and innovation in the context of mature industries.

1.2 Study purpose, research questions and structure of the dissertation

To address the identified research gaps, the overarching aim of this dissertation is to reveal how multi-partner coopetitive R&D and innovation projects can be established and managed in the context of mature industries. Following the two main success factors for coopetitive collaborations reported in the existing literature – management of tensions and partner selection – the main aim is operationalised into the following research questions:

RQ1: How do competing companies evaluate opportunities to engage in coopetitive R&D and innovation projects in mature industries?
RQ2: How are the tensions in different project phases of coopetitive R&D and innovation projects in mature industries managed?
RQ3: How do non-competitive partners influence coopetitive collaborations in different project phases of R&D and innovation projects in mature industries?

The answers to these questions are provided by the three empirical papers incorporated into the dissertation. RQ1 focuses on the early establishment of coopetitive collaborations for R&D and innovation and is addressed in Paper 1, which aims to uncover the evaluation process carried out by competing companies when they are invited to join coopetitive R&D and innovation projects in mature industries. The perspective of invited companies, which are not in a position to choose other partners, is important since the establishment of coopetitive projects in the context of mature industries has been acknowledged as challenging due to their less visible benefits and lower initial attractiveness (e.g., Borch & Solesvik 2016). Paper 1 focuses on the pre-project phase of coopetitive R&D projects in mature industries, uncovers a two-step evaluation process and reveals certain influences of non-competitive partners on the decisions of competing companies to join – or not join – projects to which they have been invited. Paper 1 thus addresses gaps research gaps 1, 2 and 3; it further serves as an input for Papers 2 and 3.

The second RQ is addressed by Paper 2, which uses paradox theory and Smith and Lewis's (2011) classification of organisational tensions as lenses to deeply

explore the types of tensions that arise in cooperation between competing companies and specific approaches to their management across two project phases: the pre-project phase and the project implementation phase. By paying attention to distinct project phases in the context of mature industries, Paper 2 addresses research gaps 2 and 3.

The third RQ is addressed by Paper 3, which was developed based on insights from Paper 1 that revealed the roles of non-competitive partners in the establishment of coopetitive innovation projects. Paper 3 illuminates the roles and influence of non-competitive partners on competitor-to-competitor relationships in both the pre-project and project implementation phases of coopetitive R&D projects; it thus addresses all three identified research gaps.

The three empirical publications in this dissertation apply project-level analysis to address their specific aims. However, certain insights from Papers 1 and 2 are related to individual companies. For instance, Paper 1 details the evaluation of project opportunities carried out by individual companies. Similarly, Paper 2 reveals tensions within companies as factors that hinder cooperation during the pre-project phase and the need for managing certain types of tensions at both the firm and project levels. Both examples showcase an overlap between the firm and project levels that must be considered holistically to successfully manage coopetitive innovation projects in mature industries.

1.3 Positioning and scope of the research

The research conducted in this dissertation lies at the intersection of coopetition, innovation and R&D phenomena empirically explored in the context of mature industries, with the project as the main unit of analysis, as illustrated in Figure 1.

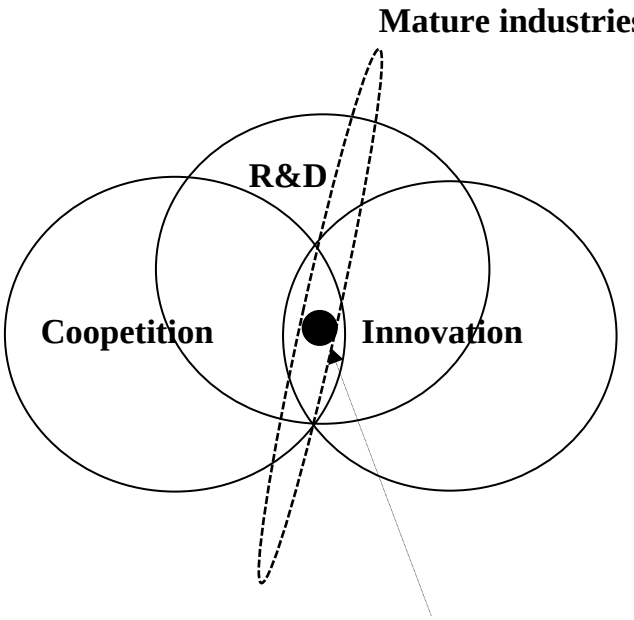

Figure 1: Positioning of the research

A management perspective has been applied to explore the intersection of three phenomena, where 'phenomenon' is defined as 'a perceived fact, change, or event that can be scrutinised or studied and especially something that is unexpected or in question' (Schwarz & Stensaker 2016, p. 2). The innovation management literature focuses on the management of innovation as the use of existing opportunities to create novel ideas and capture value through bringing them to the world (Tidd & Bessant 2013, p. 58). Broadly, innovation can be viewed as a change related to products or services (product/service innovation), the ways they are delivered (process innovation), the context (position innovation) or the business logic or model (paradigm innovation; Tidd & Bessant 2013, p. 59). The innovation management research stream explores both the management of internal innovation processes within companies and the management of innovation in collaboration with external partners, or the OI processes defined by (Chesbrough & Bogers 2014) as 'a distributed innovation process based on purposively managed knowledge flows across organizational boundaries' (p. 7). OI happens through the interaction between companies and a variety of actors inside and outside organisation's boundaries: customers, universities, suppliers, competitors and so on. Even though this dissertation does not directly focus on knowledge sharing mechanisms, it explores the establishment and management of coopetitive R&D collaborations that aim at knowledge sharing in order to reach desirable

outcomes; therefore, the dissertation builds on the research into OI practices between competitors (Mention 2011; Ritala & Sainio 2014).

Coopetition represents simultaneous cooperation and competition between competing companies for various purposes (Czakon, Mucha-Kuś & Sołtysik 2016; Trapp et al. 2020). The coopetition research stream explores cooperation between competitors that aims at different purposes such as setting up industry standards, achieving economies of scope, joint distribution, increased sales or greater innovation (Bengtsson, Raza-Ullah & Vanyushyn 2016; Roig-Tierno, Kraus & Cruz 2018). This dissertation primarily builds on the foundational work in the substream that explores the management of collaboration between competitors for innovation (e.g., Fernandez & Chiambaretto 2016; Pellegrin-Boucher, Le Roy & Gurău 2018).

The R&D phenomenon has been explored in various fields, including the social and natural sciences, arts and engineering (Nobelius 2004). This dissertation takes a management perspective on R&D. According to the OECD's *Frascati Manual*, R&D comprises systematic activities undertaken to increase the stock of knowledge and enhance applications of already available knowledge (OECD 2015, p. 44). R&D activities may enhance a firm's learning and adaptation to change and its growth and innovation (Cohen & Levinthal 1989; Demirel & Mazzucato 2012). Therefore, while R&D activities are very broad, the part of R&D activities that enhances new or improved products, processes and services way to the market can be considered part of innovation activities. This perspective that considers R&D activities as activities leading to innovation has been followed in this dissertation. The R&D management research stream explores R&D as innovation activities both within companies and with other market or research partners (Du, Leten & Vanhaverbeke 2014). Today, turbulent technological and economic conditions lead companies towards R&D collaborations with external partners (Cho & Lee 2019; Ritala & Sainio 2014). Collaborative R&D partnerships enable risk sharing, provide access to necessary capabilities and knowledge and enhance the development of a company's own capacities and may be beneficial for innovation in the long-term (Cho & Lee 2019). R&D collaborations involving competitors have long been recognised as particularly beneficial in technologically turbulent fields (Ritala & Sainio 2014). This dissertation explores coopetitive R&D collaborations that involve both competitors and non-competitive partners.

Lastly, the research focus of this dissertation is on the project, defined as 'a

temporary endeavour undertaken to create a unique product, service, or result' (Project Management Institute 2017) The R&D and innovation projects in this dissertation are explored in the context of mature industries that have passed through the emerging and growth phases but have not reached the decline phase. One characteristics of these industries, as the literature indicates, is that they are still trying to find an appropriate balance between open and closed innovation practices (e.g., Caiazza 2015). Those conditions certainly influence their collaborative relationships with external partners and thus present a particularly relevant context for this dissertation. More details on each of the aspects presented in the Venn diagram in Figure 1 are provided in chapter two, the literature review.

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2 Literature review

This chapter provides an overview of the background literature and aims to orient the reader regarding the topic of this dissertation. The first section introduces the phenomenon of innovation, describes the evolution of the innovation management field and discusses innovation in collaboration with external partners, which is particularly relevant for this thesis. The second section introduces the phenomenon of coopetition and focuses on coopetition for innovation, theoretical perspectives in the coopetition literature and the two critical factors for successful coopetitive collaborations: partner selection and management of tensions. The third section is related to the R&D phenomenon, the fourth provides an overview of the specifics of the mature industry context, particularly in manufacturing industries, and the concluding section elaborates on the project perspective applied in the dissertation.

2.1 Phenomenon of Innovation

While classical economics prioritised the role of capital, land and labour over the role of innovation for economic progress in the equilibrium economy, Joseph Schumpeter (1934) has been acknowledged as the foremost pioneer of the economic analysis of innovation and the notion of innovation as a key driver of economic and social change. According to Schumpeter, continuous technological innovation is the main driver of economic growth and the dynamics of business cycles, while technological maturity spurs new waves of innovation that are known as ‘creative destruction’ (Block, Fisch & van Praag 2017). Unlike the exogenous understanding of innovation favoured by neoclassical economics, Schumpeter perceived it as endogenous to a system and claimed that competition was based on the introduction, adoption and diffusion of innovation, with the imitative nature of innovation fostering constant creative innovation response from companies (Scherer 2001). Schumpeter also clarified the distinction between invention and innovation, understanding innovation as an invention that has been given a commercial purpose (Ruttan 1959). Furthermore, entrepreneurship was introduced as a connecting link between innovation and economic development, with entrepreneurs as the main actors involved in establishing new companies and creating change (Antonelli 2009; Mehmood et al. 2019). Later, Schumpeter also acknowledged the innovation potential of large companies; their higher levels of

competence and greater resources, among other factors, could increase the efficiency of their innovation efforts and reduce the risks of imitation (Antonelli 2009). Schumpeter's view of innovation is only one of the traditions in research on innovation and is certainly not without its limitations (Nelson 2012; Tzeng 2009), but it is widely acknowledged as a founding contribution to the conceptualisation of innovation and entrepreneurship.

There are numerous definitions of innovation. Schumpeter defined it as a new combination of resources and knowledge, recognising innovation of products or services, process innovation, innovation in organisation of an industry, input or material innovation and market innovation (1934, p. 76). Numerous authors have defined innovation as a process (Hidalgo & Albors 2008), such as a problem-solving process (Dosi 1982), a learning process (Cohen & Levinthal 1990; Dodgson 1991) or a knowledge exchange process (Patel & Pavitt 1994). There are also more holistic perspectives on innovation. Tidd and Bessant (2013), for instance, define innovation as a change in product or service, process, context or paradigm. On the level of practice, the *Oslo Manual* was introduced by the OECD under the Technology/Economy Programme in 1988 (OECD 2005) to ensure an internationally standardised understanding, conceptualisation and measurement of innovation (Lazzarotti, Dalfovo & Hoffmann 2011). The *Oslo Manual* pinpoints knowledge, novelty, utility, value creation and preservation as underlying components for conceptualising innovation, acknowledging that innovation comprises both activities and outcomes. According to an earlier version of the *Manual*, innovation is 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method or a new organizational method in business practices, workplace organization or external relations' (OECD 2005, p. 55). This definition comprises product, process, marketing and organisational innovation. A slightly different definition, which uses only two types of innovation, was offered in 2018: 'An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)' (OECD 2018, p. 20). Even though there are numerous definitions of innovation, common to most are the requirements of some level of novelty and that the result of the innovation be put to use.

2.1.1 Innovation Management Research and the Open Innovation Paradigm

The innovation management research field has grown exponentially in recent decades. Broadly speaking, two perspectives in the innovation management research can be observed: one seeks to identify the best innovation management practices during different historical periods (Liyanage, Greenfield & Don 1999; Miller 2001; Niosi 1999; Rothwell 1994), and the other asserts the importance of context and adopting a contingency-based approach to innovation management (Castellacci 2008; Ortt & van der Duin 2008; Pavitt 1984; Tidd 2001). Scholars adopting the first perspective have proposed dominant innovation management models for different historical periods, although the number of periods and their start and end dates may be defined slightly differently across studies (Miller 2001; Rogers 1996). However, new periods are always considered an opportunity to adapt to emerging conditions and overcome the shortcomings of earlier periods (Ortt & van der Duin 2008). Table 1 presents an overview of innovation management approaches across different periods based on material from several studies. The time periods have been defined following Ortt and van der Duin (2008).

Table 1: Evolution of innovation management approaches.

Period	Context	Innovation approach
From the Second World War to the mid-1960s	Post-war society, governments and organisations favour scientific and technological progress and innovation to ensure economic growth and satisfy emerging demand. Emergence of new industries.	Technology- and science-driven approach, with less attention to commercial aspects. Shift from relatively isolated corporate R&D and innovation to implementation of basic project management.
From the mid-1960s to the late 1970s	Slower economic growth and more competitive markets, with a regulated demand side. Organisational focus on economies of scale and diversification.	Innovation primarily driven by market needs, mainly internally organised in collaboration between different business units and through multi-disciplinary projects.
From the late 1970s to the early 1990s	Oil crises and recessions accompanied by inflation, decreases in demand and high unemployment rates. Organisational focus on cost control and cost reduction.	Innovation projects driven by market needs and most recent technology. Focus on product and process innovation and more flexible collaboration with internal and external partners for the

		establishment of technological capabilities.
From the early 1990s to the early 2000s	Globalisation, increased competition and use of new information and communication technologies influence internal organisations of companies and establishment of external alliances and networks. Competition is based on time-to-market.	Market and business models of innovation and new business development through innovation alliances and networks, mainly with suppliers and customers. Rise of the internet and other information technologies influence how companies share and manage knowledge flows for innovation both within and across organisational boundaries. Increasing complexity of coordination and management of those relationships.
From early 2000s to the present	Globalisation, dynamic technological change, increased competitive pressures, fourth industrial revolution, technological convergence, blurring boundaries between industries and disruptions of established industries. Effective implementation of innovation of crucial importance for competitive advantage.	Business model innovation, service innovation, servitisation and digital innovation. Dominance of OI paradigm, which implies collaborations for obtaining knowledge from scientific partners, customers, suppliers and competitors. Rise of crowdsourcing and emergence of digital platforms and ecosystems. Digital technologies significantly influence how organisations and individuals collaborate for innovation. Technological partnerships established within and across industries. Complexity of collaborations pose numerous managerial, organisational and coordination challenges.

The information in the table is drawn from several sources (Aas 2011; Aas & Pedersen 2016; Enkel, Bogers & Chesbrough 2020; Hacklin, Klang & Baschera 2013; Hacklin, Marxt & Fahrni 2010; Niosi 1999; Nobelius 2004; Ortt & van der Duin 2008; Salampasis, Mention & Torkkeli 2014).

One of the criticisms of the evolutionary perspective is that a dominant innovation model does not necessarily become obsolete after a certain historical period ends; similarly, the same model is not the most suitable for all companies or industries, and there might be other models more relevant for a particular context (Ortt & van der Duin 2008). Therefore, numerous contingencies need to be taken into account. Pavitt's (1984) ground-breaking work started debates on the

contingency perspective on innovation management by identifying different technology sources, user requirements and means and appropriation as major contingencies that influence technical change generally and the technological trajectories of companies in different sectors. A more recent contribution on the same topic has been made by Castellacci (2008), who developed a new sectoral taxonomy that combines manufacturing and service industries based on two contingent factors: function within the economic system and pervasive innovation mode or technological trajectory. That being said, numerous authors follow a contextual approach, where innovation type and organisational structure, as internal factors, and industry type and country, as external factors, combine to determine the most suitable innovation management approach (Blais & Miller 1993; Brown & Eisenhardt 1997; Ortt & van der Duin 2008). Similarly, Tidd (2001) identified complexity and uncertainty as the main environmental contingencies affecting the type, organisation and management of innovation. Overall, scholars applying this perspective depart from the 'one-size-fits-all' idea and acknowledge the peculiarities of social, technological and market environments as underlying factors that affect the best innovation solutions for a given context.

The importance of opening up the innovation process to achieve competitive advantage, better market position and enhanced performance and growth is now widely acknowledged in our age of knowledge and digitalisation (Mention 2011; Nambisan et al. 2017). As Table 1 shows, OI became the new dominant paradigm for innovation and its management over the last two decades. Even though the idea of collaborative innovation and sourcing valuable ideas outside firm boundaries is not new (West et al. 2014) and indeed was recognised by scholars decades ago (Freeman 1979; Gibbons & Johnston 1974; von Hippel 1986), it has attracted vastly more research interest since Chesbrough introduced the concept of OI: 'Open Innovation means that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well' (2003, p. 43). This definition has evolved over time to emphasise knowledge flows: 'Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively' (Chesbrough 2006, p. 1), based on relationships with other actors: 'a distributed innovation process based on purposively managed knowledge flows across organisational boundaries using pecuniary and non-pecuniary mechanisms

in line with the organization's business model' (Chesbrough & Bogers 2014, p. 7). Gassmann and Enkel define three core processes that underlie OI:

> (1) The outside-in process: Enriching a company's own knowledge base through the integration of suppliers, customers, and external knowledge sourcing can increase a company's innovativeness. (2) The inside-out process: The external exploitation of ideas in different markets, selling IP and multiplying technology by channelling ideas to the external environment. (3) The coupled process: Linking outside-in and inside-out by working in alliances with complementary companies during which give and take are crucial for success. (2004, p. 1)

It is also important to clarify, in light of the evolutionary and contingency perspectives on innovation management discussed above, that, although the OI paradigm can be considered prevalent in the current era, even Chesbrough (2003) indicates that it might not be applicable to all industries, some of which will continue to operate under a closed innovation regime. In this way, Chesbrough acknowledges the importance and persistence of the contingency perspective.

OI involves both benefits and challenges. For instance, it enables companies to reduce costs, mitigate risk and reach new markets by using a broad range of knowledge sources from collaborations with customers, suppliers, competitors and academics or to share their knowledge and resources (West & Gallagher 2006). The most widely recognised benefits of collaboration with science partners and research institutions are related to their vast technological expertise and knowledge potential, which can facilitate organisational learning and knowledge creation (Jakobsen & Steinmo 2016). 'Vertical collaboration,' which refers to collaboration with suppliers and customers, is usually motivated by cost reduction, acquiring complementary knowledge and skills and reducing market risks (Mention 2011). Collaboration with competitors, or 'horizontal collaboration,' another type of OI, is motivated by organisational learning, technological development, creating new products and obtaining complementary resources (Cygler et al. 2018; Mention 2011). When discussing OI between competitors, which is particularly relevant for this dissertation, Le Roy and Chesbrough (2018) have offered an important clarification. According to them, this type of OI can be achieved based on knowledge flows between competitors both with and without collaboration through selling or buying. Furthermore, as to the three main OI processes – inside-out, outside-in and coupled – Le Roy and Chesbrough (2018) indicate that, in the case of OI between competitors, the most common in practice and thus most heavily studied are coupled processes in which competitors mutually open up their

innovation processes. On the contrary, there has been less practical and research interest in outside-in processes that involve using knowledge from other competitors to create one's own technology and inside-out processes that entail opening up and enabling competitors to use a company's knowledge.

Besides the benefits, scholars have also identified certain OI paradoxes. The 'paradox of openness' is rooted in the need to open up for collaborative value creation while individually capturing part of the commonly created value (Laursen & Salter 2014), which implies a risk of losing knowledge, technology or resources and need for an appropriate balance between knowledge sharing and knowledge protection (Chesbrough & Brunswicker 2014). The 'disclosure paradox' is related to decisions between knowledge sharing and knowledge protection, when the collaborative outcome involves high risks and cannot be clearly predicted (Dahlander & Gann 2010). Scholars agree that, among the various types of OI collaborations, OI paradoxes may be of greatest intensity between competitors (Le Roy & Chesbrough 2018).

During almost two decades of OI research, some of the most heavily studied topics are inbound OI practices based on inside-out processes, organisational culture, competences, motivation and appropriability as enablers of OI. Scholars have called for a deeper understanding of outbound OI practices based on outside-in processes, OI failures (West & Bogers 2014; West et al. 2014), OI between competitors (Le Roy & Chesbrough 2018) and the nature, partners and sources of OI in the digital age (Enkel, Bogers & Chesbrough 2020).

2.2 The phenomenon of coopetition

As Simmel (2008) notes, dualities and dichotomies, including competition, are necessary for the existence of the society. Their outcomes are not necessarily bad; indeed, they are often considered driving forces that push society forward.

Competition has long been a core topic in economics, and a brief overview from the economic perspective follows. Starting with classical economics and Adam Smith's *Wealth of Nations* (1976), 'free competition' has been seen as a rivalrous market process and regulatory force on individual interests that ensures that market prices reflect real production costs. In this way, competition became a central concept of economic analysis that regarded ensuring lower prices for consumers and controlling sellers as leading to greater wealth for society as a whole (Smith

1976). Market competition was also accepted as an essential regulatory economic mechanism by political economists like David Ricardo (1817) and John Stuart Mill (1848). Inspired by classical economists, Karl Marx perceived competition as a battle (1847) and central to the laws of accumulation of capital by capitalists within and between industries (1867). Neo-classical economists were particularly keen to regard a static form of competition as a basic market structure. The groundwork of Augustin Cournot (1838) was the concept of 'perfect competition', which is a state of the market where supply and demand determine prices, on the assumption that all participants in the market have perfect information about costs and prices and that consumer preferences are given. Over time, this view of 'perfect competition' as a state was replaced with a notion of competition as a dynamic rivalry process (Clark 1961; Hayek 1978). This also gave rise to debates about whether imperfect (monopolistic) competition may be closer to actual economic reality (Shove 1933), which led to governmental regulation of economic imperfections as a solution to enable a situation closer to perfect competition (e.g., Stigler 1957). Schumpeter (1954) and evolutionary economists also focused on the dynamics of competition, as opposed to its static process, regardless of whether it was perfect or imperfect (McNulty 1968). This dynamic approach to competition has remained important and became common in the business literature (e.g., Porter 1990), while monopolistic competition and the notion of bounded rationality (Kirzner 1978) came to the fore again in 1980s as a base for Keynesian macroeconomic models (Startz 1989).

From a sociological perspective, competition may be considered an indirect battle that, unlike direct confrontations, aims to create something socially valuable and ensures progress (Simmel 2008). Furthermore, it better satisfies the needs of a certain audience. However, relations with the audience, relationships between competitors and the outcomes of competition may vary in different fields (Werron 2015). In some areas like journalism, competition leads to more homogeneity, while in others like the arts and scholarly research, it may spur creativity. Scholars also question whether the focus of modern competition is on the audience, on companies' perceptions of audience opinions, mediators between companies and the audience or solely the actions of the competitors, since those might offer the clearest guidance regarding the needs of the audience (Werron 2015). Therefore, historically, certain socialising effects and evolution in the relationships between competitors have been noted (Simmel 2008) which, in my opinion, indirectly tend

towards coopetition as the latest relational form, resulting from the external push to ‘cooperate and survive, or die’, as is true of today’s technological pressures.

Therefore, the next term at the core of inter-organisational relationships and relevant for coopetition is ‘cooperation.’ Some scholars use this term interchangeably with ‘collaboration’ or ‘coordination’ (Wankmüller & Reiner 2020). For instance, Hardy, Phillips and Lawrence (2003) define collaboration ‘as a cooperative, inter-organisational relationship that is negotiated in an ongoing communicative process’ (p. 323). Some other authors consider those terms to be complementary or try to establish a certain structure to their use (Gulati & Singh 1998). Gulati, Wohlgezogen and Zhelyazkov (2012), for instance, perceive cooperation and coordination as two facets that determine the success of collaboration and define inter-organisational cooperation as the ‘joint pursuit of agreed-on goal(s) in a manner corresponding to a shared understanding about contributions and payoffs’ (p. 6), while coordination is ‘the deliberate and orderly alignment or adjustment of partners’ actions to achieve jointly determined goals’ (p. 12). According to this view, organisations agree on the intended inputs and expected outputs which together define the extent of cooperation. However, subjective perceptions, expectations and evaluations of other partners’ behaviour may emerge during cooperation and require coordination mechanisms. Castañer and Oliveira (2020), in one of the latest literature reviews, analyse prior collaboration, cooperation and coordination definitions in inter-organisational relationship studies and propose a way to distinguish the meanings of the terms. First, the authors indicate three aspects that are used differently in those definitions: attitude, behaviour and outcome. They show that collaboration definitions generally relate to behaviour and then outcome, while attitude is often neglected; coordination definitions focus solely on behaviour, while cooperation definitions focus on behaviour and then attitude, only dealing with outcomes to a very limited extent. Castañer and Oliveira (2020) further propose that ‘coordination refers to the joint determination of common inter-organisational relationship goals, while cooperation refers to the implementation of those goals’ (p. 984) based on the attitudes that evoke behaviours and lead to outcomes: that is to say, achieving the goals. According to Castañer and Oliveira (2020), ‘collaboration refers to voluntarily helping other partners to achieve common goals or one or more of their private goals’ (p. 986). The difference indicated in those

definitions is that cooperation is directed towards a common goal while collaboration may be helpful for achieving private goals as well.

Most researchers consider Raymond John Noorda, founder and CEO of the American software company Novell, as the one who coined the term 'coopetition,' based on a combination of competition and cooperation (Chiambaretto & Dumez 2016; Zakrzewska-Bielawska 2015). He pointed out the importance of coopetition for the computer industry in the 1990s (Bouncken et al. 2015). Brandenburger and Nalebuff's *Co-opetition*, published in 1996, was crucial to generating a wider awareness of the changes in business strategy based on a new kind of relationship between companies, a relationship rooted in game theory. Brandenburger and Nalebuff explain the coopetition model through 'value net' processes between suppliers, customers, competitors and complementors. According to these authors, coopetition allows players to move from a 'winner-take-all' position to shared benefits for all, provided that competitors join forces. The crucial part of the game is to understand the factors that led to cooperation or coopetition in the first place and to decide when to follow one approach rather than the other.

In 2000, Bengtsson and Kock provided a new definition: 'The most complex, but also the most advantageous relationship between competitors is 'coopetition' where two competitors both compete and cooperate with each other' (p. 411). Later, the same authors acknowledged that more than two firms can cooperate and compete at the same time: 'Our new definition suggests that coopetition is a paradoxical relationship between two or more actors, regardless of whether they are in horizontal or vertical relationships, simultaneously involved in cooperative and competitive interactions' (Bengtsson & Kock 2014, p. 180). Even though those definitions use 'cooperation,' the terms 'cooperation' and 'collaboration' are often used interchangeably in the coopetition literature (e.g., Chiambaretto, Maurice & Willinger 2020; Ritala 2012).

Two aspects of the definitions require further discussion: the paradoxical nature of coopetition and horizontal versus vertical coopetitive relationships. As noted above, coopetition has been recognised as a paradox (Jakobsen 2020; Lundgren-Henriksson & Kock 2016; Pellegrin-Boucher, Le Roy & Gurău 2013) that entails two simultaneous but contradictory logics: cooperation based on common interests and competition based on conflicting interests (Bengtsson & Kock 2000). Therefore, 'simultaneous' is key and, contrary to Brandenburger and Nalebuff's (1996) definition, there is no clear option to choose when to pursue one or the other

(Bengtsson, Raza-Ullah & Vanyushyn 2016) since that would not be genuine coopetition but rather isolated competition or cooperation (Luo 2007). Bengtsson and Kock's (2014) definition thus builds on Smith and Lewis's (2011) understanding of paradox: 'contradictory yet interrelated elements (dualities) that exist simultaneously and persist over time; such elements seem logical when considered in isolation, but irrational, inconsistent, and absurd when juxtaposed' (p. 387). The intensity of coopetition and competition between partners may vary due to different motives and interests (Dahl 2014). Companies may share knowledge and expertise to achieve common benefits while at the same time opportunistically trying to obtain private gains and prevent knowledge leaks (Gast et al. 2019; Raza-Ullah, Bengtsson & Kock 2014). Therefore, Bengtsson, Raza-Ullah and Vanyushyn (2016) differentiate between the balanced coopetition paradox, when cooperation and coopetition are simultaneously high or low, and there is an unbalanced paradox that is dominated by either coopetition or cooperation. Scholars agree that a reasonably balanced paradox is not only beneficial but also necessary for coopetitive collaborations (Dagnino & Padula 2002).

Another aspect worth noting is the classification of horizontal and vertical coopetition. According to Chiambaretto and Dumez (2016), horizontal relationships exist between competitors operating in the same market based on the same activities; supplier-retailer relationships represent vertical relationships, while a combination of horizontal and vertical relationships means that companies horizontally compete and vertically cooperate. These clarifications are very important since relationships between competition and cooperation are not stable over time and may be influenced by changes in the environment and companies' learning processes (Dahl 2014) and by industrial or institutional changes and the product lifecycle (Akpinar & Vincze 2016). Therefore, it may be difficult to make a clear distinction between the roles of companies involved in coopetition. A company may be a competitor today but become a supplier or customer in the near future, and the supplier in one activity might be a competitor in another (Ritala & Tidström 2014). Coopetitive projects explored in this dissertation involve several competing companies engaged in horizontal coopetition; that is, they are all present in the same market.

2.2.1 Coopetition for innovation

To successfully innovate in today's highly dynamic and challenging business environment, companies rely extensively on a variety of external sources of knowledge and resources (Navío-Marco, Bujidos-Casado & Rodrigo-Moya 2019). One is cooperation with competitors, which has attracted growing research attention in recent years (Dorn, Schweiger & Albers 2016); scholars have noted the benefits of coopetition for innovation in uncertain and dynamic markets and resource-limited environments (Roig-Tierno, Kraus & Cruz 2018). It has been argued that sharing common knowledge and complementary resources between competitors can reduce costs and risks (Luo 2007), stimulate value creation and innovation and help with entering new markets and developing new products (Roig-Tierno, Kraus & Cruz 2018). However, this type of cooperation for innovation is accompanied by a high risk of technology imitation, knowledge and expertise leaks, weakening of market position and even the risk that competitors will enter a target market (Gnyawali & Park 2011a; Ritala & Hurmelinna-Laukkanen 2009).

Since collaboration between competitors has been acknowledged as a type of OI (see section 2.1.1), the relationship between coopetition for innovation and OI between competitors requires further examination. Following the definition of coopetition, competitors simultaneously cooperate and compete when they engage in coopetition for innovation. However, as clarified by Le Roy and Chesbrough (2018), OI practices between competitors may not always include collaboration and may be based only on selling or buying knowledge such as licensing or buying patents. These cases cannot be considered coopetition for innovation. Furthermore, Le Roy and Chesbrough (2018) introduced the new concept of 'open coopetition' (p. 404) that refers only to OI between competitors that includes collaboration. Even though I do not specifically use the term 'open coopetition' in this dissertation, I apply a coopetition lens to explore cooperation between competitors for innovation which, according to Le Roy and Chesbrough (2018), aligns with OI between competitors that includes collaboration.

Despite increasing research interest in coopetition for innovation, scholars still claim its infancy (Ritala, Kraus & Bouncken 2016), mainly due to a large number of contradictory findings. For instance, there are a considerable number of quantitative studies seeking to explain the effects of coopetition on innovation

performance. Gnyawali and Park (2009) identified positive effects, while Bengtsson, Eriksson and Wincent (2010) argued that coopetitive tensions ultimately undermine innovation performance. Some studies identified positive effects on incremental (Lassen & Laugen 2017; Ritala & Hurmelinna-Laukkanen 2013) and radical (Boucken & Fredrich 2012; Bouncken & Kraus 2013) innovation. By contrast, other studies have shown that collaboration with competitors negatively influences the degree of novelty in innovation (Mention 2011) and radical (Ritala & Sainio 2014) or even revolutionary (Bouncken & Kraus 2013; Nieto & Santamaría 2007) innovations. Furthermore, there are authors who claim neutral effects (Santamaría & Surroca 2011); more recently, Jakobsen and Steinmo (2016) argued that R&D collaboration between competitors may be more beneficial than product innovation since it takes place far away from customers. The largely quantitative nature of these studies and their divergent findings may be interpreted as a need for more in-depth qualitative research.

Thus, coopetition for innovation has been recognised as one of the most promising research areas within the coopetition field (Bouncken et al. 2015). Ritala, Kraus and Bouncken (2016) identified four main discourses in research on coopetition for innovation: 1) the effects of coopetition on innovation outcomes; 2) tensions, dynamics and interactions in coopetitive relationships; 3) coopetitive value creation and appropriation; and 4) coopetition in networks and ecosystems.

Scholars have noted the need for more insights into coopetition for innovation in a variety of contexts and environments (Ritala, Kraus & Bouncken 2016) and in the specific context of mature industries (Jakobsen 2020; Mathias et al. 2018), coopetitive collaborations between companies of different size, collaborations at different levels, including the project level (Ritala, Kraus & Bouncken 2016), and coopetition between multiple partners beyond the competitor-to-competitor dyad (Czakon et al. 2020; Rouyre & Fernandez 2019). They have also called for a better understanding of the mechanisms that influence trust and distrust in coopetitive interactions at multiple levels (Kostis & Näsholm 2020), the managerial principles, processes and capabilities critical for coopetition success, the manifestation of tensions during coopetition phases and their influence on outcomes and the conditions that lead to coopetition failures (Czakon et al. 2020).

2.2.2 Theoretical perspectives on coopetition for innovation

Several theoretical perspectives have been used to enrich our understanding of coopetition for innovation as an emerging and complex phenomenon. A summary of the most commonly used theoretical perspectives is provided in Table 2.

Table 2: Theoretical perspectives on coopetition for innovation

Transaction cost economics	**Resource-based view**	**Dynamic capabilities theory**	**Game theory**	**Inter-firm network theory**	**Contingency theory**	**Paradox theory**
Focus on the best exchange form for minimising exchange costs Common goals but conflicting interests between competitors Opportunistic behaviour and knowledge leaking in coopetition increase monitoring, 'safeguarding' and coordinating costs	Resources as the main determinant of firm performance and competitive advantage Competitors have relevant and complementary resources and high absorptive capacities Coopetition provides access to resources, reduces costs and facilitates tacit knowledge transfer and rapid learning	Dynamic capabilities as a source of competitive advantage in rapidly changing environments Coopetition is beneficial for developing dynamic capabilities within organisations and at the inter-organisational level	Interdependencies among firms and actions can manipulate value creation and capture Collaboration between competitors might be a mechanism for avoiding mutually destructive outcomes Coopetition can provide optimal outcomes in certain areas with repeated engagements	Cooperative relations between competitors form a coopetition network Ties in relationships between multiple actors facilitate flow of assets and information and influence firm behaviour and performance Central and structurally autonomous network positions are beneficial for innovation and market performance	Optimal organisational structure in intersection of internal and external contingency factors Various inter- and intra-organisational contingency factors influence innovation outcomes of coopetition	Simultaneous competition and cooperation constitute coopetition paradox Coopetition paradox may manifest at the inter-firm, intra-firm and individual levels Tensions that appear due to coopetition paradox require paradox management styles that address both divergences

Source: Based on Charleton, Gnayawali and Galavan (2018, pp. 24–28).

Transaction cost economics postulates that minimal exchange costs determine the most efficient form of organising transactions, within or outside firm boundaries (Williamson 1975, 1979). When exploring coopetition, this theoretical perspective focuses on the costs caused by high risks of opportunistic behaviour guided by the individual interests of competing companies (Dagnino 2007; Padula & Dagnino 2007). From this point of view, coopetition carries high risks of unintended knowledge spill-over and high value appropriation risks that increase monitoring, contracting and coordination costs (Estrada, Faems & de Faria 2016; Fernandez et al. 2018; Ritala & Hurmelinna-Laukkanen 2009). Therefore, transaction cost economics emphasises competitive over cooperative aspects; from this perspective, coopetition is seldom perceived as a fruitful strategy for innovation and may often have a negative influence on innovation performance (Nieto & Santamaría 2007; Santamaría & Surroca 2011).

The resource-based view emphasises the importance of rare, valuable, inimitable and non-substitutable resources as sources of a firm's sustained competitive advantage (Barney 1991; Penrose 1959). Collaboration with competitors offers the opportunity to obtain complementary or combine homogeneous resources in a short period of time and at lower cost and lesser risk than would be true of internal development of those resources (Bengtsson, Eriksson & Wincent 2010; Mention 2011; Ritala & Sainio 2014). The high absorptive capacities of collaborating partners enhance knowledge transfer and learning (Dussauge, Garrette & Mitchell 2000); if misused, however, they may undermine collaborative performance and superior value creation (Fernandez et al. 2018).

While the resource-based view analyses the possibility of obtaining resources and achieving a sustained competitive advantage, the dynamic capabilities theory focuses on 'the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing business environments' (Teece, Pisano & Shuen 1997, p. 516) and directs attention to the changing nature of business environments and the strategic management of the internal and external capabilities necessary for properly responding to those changes. As Teece (2014) makes clear, ordinary capabilities – perceived as 'doing things right' – allow the firm to achieve great efficiency, but they cannot ensure competitiveness in uncertain and rapidly changing markets and business environments. By contrast, the successful building of dynamic capabilities and their continuous fine-tuning –

described as ‘doing the right things at the right time’ – allow the company to respond to and align with innovation and change (Teece 2014). However, the ability of top management to identify the most promising trends and guide the company in their direction must be coupled with organisational strategies, values and culture that are supportive of the changes that are needed (Teece 2014).

According to Teece (2007), the development of dynamic capabilities is based on sensing, seizing and transforming abilities. Sensing, in the form of scanning the environment, identifying and assessing opportunities is the first step on this path (Teece 2007). In coopetition for innovation, this might be a crucial step in identifying the relevant partners for achieving the target capabilities. As Teece (2018) argues, this step might be motivated by a capability gap, measured by technical, market and business model distance between existing capabilities and those the company is trying to achieve. Seizing activities represent a ‘mobilization of resources to address needs and opportunities, and to capture value from doing so,’ while transforming activities are necessary to maintain the alignment of capabilities with organisational strategy and the requirements of the external business environment (Teece 2014, p. 332).

From a dynamic capabilities theoretical perspective, coopetition is often recognised as a beneficial strategy for innovation (Fernandez, Le Roy & Chiambaretto 2018; Gnyawali & Park 2009, 2011b; Ritala & Hurmelinna-Laukkanen 2009). When applying the dynamic capabilities theoretical perspective to explore coopetition for innovation, authors have generally elaborated on dynamic capabilities *within* organisations. However, Teece (2012) implies that not all dynamic capabilities reside within an organisation and that some may be gained through alliances with other companies. This notion has been the starting point for more recent considerations of the possibility of co-creation of dynamic capabilities at the inter-organisational level. Giudici, Reinmoeller and Ravasi (2018), for instance, explored the opportunities for developing dynamic capabilities at the level of business incubators and other national or regional agencies based on the interactions of various actors, not competitors specifically. Bez and Chesbrough (2020) explored sensing, seizing and transforming activities at the level of a non-profit organisation formed as a partnership between competing companies.

Game theory (Nash 1950) proposes that inter-firm collaborations are motivated by expected net positive values of alliance outcomes. Individual gains are dependent on joint outcomes, which, due to the high interdependence of the actions

of the firms involved, may be manipulated (Parkhe 1993; Parkhe, Rosenthal & Chandran 1993). From the game theory perspective, coopetition may mitigate mutually destructive collaborative outcomes since cooperative norms (Ritala & Hurmelinna-Laukkanen 2009) may enhance mutual payoffs in certain areas (Ritala 2012), based on repeated engagements that make firm a desirable collaborative partner (Fernandez et al. 2018; Gulati, Nohria & Zaheer 2000). Game theory has proven valuable in exploring coopetition (Gnyawali & Park 2009), especially from the perspective of economics (Okura & Carfì 2018).

Inter-firm network theory (Gulati 1998) focuses on economic activities organised through inter-firm cooperation and coordination where the major challenge may be finding an appropriate balance between differentiation and integration (Grandori & Soda 1995). In this setting, the position of the firms, the strength of their ties and the nature of the relationships among them can all influence the flow of resources and information and collaborative outcomes along with individual firm performance (Gnyawali & Madhavan 2001; Gulati 1998). Coopetitive networks include simultaneous cooperation and competition between numerous competitors (Dagnino & Rocco 2009). In this type of inter-firm network, a firm's position reflects resource asymmetries and influences competitive actions (Gnyawali, He & Madhavan 2006). The central network position has been recognised as the most prominent since it enables higher levels of autonomy, a greater number of relationships and a larger volume and diversity of competitive actions (Gnyawali, He & Madhavan 2006; Sanou, Le Roy & Gnyawali 2016).

The use of a contingency perspective on coopetition (Estrada, Faems & de Faria 2016; Qi Dong, McCarthy & Schoenmakers 2017; Ritala 2012) has recently been proposed as crucial for deepening our insights into the innovation outcomes of coopetition (Le Roy & Czakon 2016). Contingency theory (Lawrence & Lorsch 1967) postulates that an optimal organisational structure may be reached in the intersection between several internal and external contingency factors. Since their work, other studies have differentiated between inter-organisational contingency factors – such as environmental characteristics, market uncertainty, network externalities and competition intensity (Ritala 2012) and relational and contractual factors like communication and alliance scope (e.g., Cassiman, di Guardo & Valentini 2009; Faems, Janssens & van Looy 2010; Walter, Walter & Müller 2014) – and intra-organisational contingency factors like internal knowledge sharing mechanisms and formal knowledge protection mechanisms (e.g., Estrada, Faems

& de Faria 2016) and a firm's technological investments (Estrada & Dong 2020), which affect the innovation benefits in coopetitive relationships. Scholars also emphasise the importance of considering how bundle of both intra- and inter-organisational contingencies influences coopetition on innovation performance (Estrada, Faems & de Faria 2016).

Most theoretical perspectives applied to coopetition for innovation are highly mature, one indicator of which is the sheer number of citations that their foundational works have received. For instance, Barney (1991), has been cited about 80,730 times, Williamson (1975) 46,497 times, Nash (1950) 9,230 times and Gulati (1998) 7,744 times. Therefore, I acknowledge that most of those theoretical perspectives may be helpful in explaining certain aspects explored in this dissertation. A few such examples follow: the management of tensions may be explored by transaction cost economics; contingency theory may reveal the conditions under which specific tensions appear or which specific managerial style are effective; and dynamic capabilities theory, although it requires more firm-level data to comprehensively explain the sensing, seizing or transforming activities of competing companies, does offer a certain potential in grasping the co-creation of dynamic capabilities at the inter-organisational level. However, while many coopetition studies have used these mainstream theoretical perspectives, I have chosen to apply the lens of paradox theory, which is a relatively nascent perspective in the management and organisational fields that has nevertheless started to receive increasing research attention in the coopetition stream; for example, Smith and Lewis's (2011) ground-breaking article has now reached 2,854 citations.

Paradoxes consist of divergences that are logical in separation and absurd when combined (Lewis 2000, p. 760), and paradox theory explores contradictory elements that persist and 'managerial strategies that support contrasting elements simultaneously' (Smith & Lewis 2011). According to paradox theory, tensions 'are the underlying sources of paradoxes … [and] signify two sides of the same coin' (Lewis 2000, p. 761), which implies that tensions are inherent and even beneficial in dynamic and complex systems (Smith & Lewis 2011). This theoretical perspective has become increasingly important in a globalised, highly technologically advanced business environment where organisations constantly face the need to address emerging and divergent demands that may undermine their success or even their very existence (Smith & Lewis 2011). Paradox theory is used

to explain coopetition due to its simultaneous need to cooperate and compete. According to paradox theory, a coopetition paradox exists only if companies cooperate and compete simultaneously, even when the strength of divergences may not be equal; in other words, it recognises cooperation- and competition-dominated paradoxes (Bengtsson, Raza-Ullah & Vanyushyn 2016). Paradox theory has also been used to provide a comprehensive understanding of tensions as the manifestations of paradoxes and the managerial styles required to cope simultaneously with divergences at the inter-organisational, intra-organisational and individual levels (Bengtsson, Raza-Ullah & Vanyushyn 2016; Raza-Ullah, Bengtsson & Kock 2014; Stadtler & van Wassenhove 2016; Wilhelm & Sydow 2018). This dissertation applies the lens of paradox theory to showcase divergent tensions and ways to manage them in a dynamic and complex environment. To avoid redundancy, this approach is explained in detail in subsection 2.2.4.1.

2.2.3 Partner Selection in the Coopetition Literature

Coopetitive inter-organisational relationships comprise simultaneous collaboration between competitors based on their common interests and competition rooted in their own interests (Fernandez, Le Roy & Gnyawali 2014). Often described as paradoxical (Bengtsson, Raza-Ullah & Vanyushyn 2016; Le Roy & Fernandez 2015), coopetitive collaborations may provide benefits such as access to complementary resources and skills, reduced costs and enhanced value creation potential (Mathias et al. 2018) but may also lead to major losses due to the high risk of knowledge leaks, technology imitation and undermining the market position of the companies involved (Gnyawali & Park 2011b). The decision to engage in collaboration with competitors may therefore have long-term consequences for companies, and the coopetition literature reports that appropriate partner selection is an important strategic decision at the company level and a factor of crucial importance for the success of coopetitive collaborations (Geringer 1991; Kraus et al. 2018; Solesvik & Westhead 2010). This has also been discussed by Cummings and Holmberg (2012), who argue that incompatible partnerships may have powerfully erosive effects on collaborative outcomes that cannot be fully mitigated later – no matter what management style is applied –and by the strategic management scholars Doz, Olk and Ring (2000), who found that the way collaborations are formed may more significantly influence expectations, relationships and outcomes than their later organisation.

Even though partner selection has attracted considerable academic interest and scholars have taken various perspectives on the issue, there is still a need for more research on partner selection for coopetition (Kraus et al. 2018). Generally, the literature has explored how companies decide who to select for partnerships based on partner characteristics (e.g., Cygler & Dębkowska 2015) or relational aspects like trust and coopetitive intentions (e.g., Alves & Meneses 2015). While partner characteristics may be considered constant, relational characteristics such as interests, attitude and intentions are changeable (Bouncken et al. 2017; Ritala & Tidström 2014), and scholars have recently called for more attention to be directed to them (Kraus et al. 2018).

Broadly speaking, the criteria for partner selection in coopetitive alliances may be grouped according to Geringer's (1991) task- and partner-related criteria and Cummings and Holmberg's (2012) learning- and risk-related criteria (Kraus et al. 2018); they are not mutually exclusive since certain aspects may belong to more than one category. Task-related criteria refer to complementary tangible and non-tangible resources and skills that a desirable partner should possess (Geringer 1991). Complementary resources and technological, financial and managerial capabilities have been found to be important for joint value creation potential and therefore partner selection in coopetition (Alves & Meneses 2015; Dorn, Schweiger & Albers 2016; Gnyawali & Park 2009; Ritala & Hurmelinna-Laukkanen 2013). Partner-related criteria refer to relational aspects that may ensure the 'efficiency and effectiveness of cooperation' (Geringer 1991, p. 45). Of particular importance for efficient coopetitive partnerships are the compatibility of organisational cultures, size and structure, goals and commitment, previous collaborative experience, personal relationships and trust between partners (Alves & Meneses 2015; Bouncken & Fredrich 2012; Kostis & Näsholm 2020). There are also divergent findings. Chiambaretto et al. (2020), for instance, found that small companies choose cooperation with bigger competitors because of cost reductions and learning opportunities, while large companies select smaller competitors if there is an opportunity to reduce time-to-market. Zakrzewska-Bielawska (2015) reported that companies in emergent industries prefer coopetitive partners with compatible technology (task-related criteria) of similar or greater size and a similar position in the market; in other words, direct competitors (partner-related criteria). However, Kraus et al. (2018) found that the importance of trust and complementary perceptions meant that indirect competitors were more attractive

than direct competitors (partner-related criteria) and that compatibility of resources (task-related criteria) appeared to be irrelevant.

According to Cummings and Holmberg (2012), learning-related criteria refer to possibilities for learning and knowledge transfer between partners, including not only the evaluation of a potential partner's knowledge but also its accessibility. However, learning-related criteria may not be equally important for different firms and different industry contexts. For instance, it is typically of crucial importance in knowledge-intensive industries (Bouncken & Kraus 2013). Competitors operate in the same or similar markets and typically have similar capabilities and knowledge, but they may have different learning and knowledge-absorption capabilities (Dussauge, Garrette & Mitchell 2000; Fredrich, Bouncken & Kraus 2019) that may lead to high knowledge sharing and protection tensions (Ritala & Hurmelinna-Laukkanen 2009; Ritala, Kraus & Bouncken 2016; Tidström, Ritala & Lainema 2018).

While management of knowledge sharing and learning in coopetitive relationships has received significant attention (e.g., Yang, Zheng & Zaheer 2015), learning-related criteria for partner selection has not been explored to the same extent (Kraus et al. 2018). Alves and Meneses (2015), for instance, reported that it plays only a minor role in the partner selection process, and Fredrich, Bouncken and Kraus (2019) claim that a firm's own absorptive capacity significantly influences its learning in coopetitive collaborations and that firms should also assess their own and potential partners' slack resources that, together with previous collaboration history and interdependence, may enhance mutual learning and shorten the learning race. Lastly, Cummings and Holmberg's (2012) risk-related criteria include performance risks, relational risks that affect coordination and communication, inequality of shared risks, coopetition risks, quality risks and customer relationship risks. Chiambaretto, Fernandez and Nãsholm (2019) claim that learning from experience makes a distinction in risk preferences between experienced and inexperienced firms, with the former more willing to select close competitors than the latter, which have stronger risk-sharing criteria. Some of the ways to mitigate the risks in selecting partners for coopetitive relationships are to ensure trust, collaborate with previously known partners, build personal relationships, collaborate with partners of similar size or larger partners and collaborate with indirect competitors (Kraus et al. 2018; Solesvik & Westhead 2010; Zakrzewska-Bielawska 2015).

Furthermore, while most studies have explored partner selection in competitor-to-competitor relationships (Dorn, Schweiger & Albers 2016), several scholars have acknowledged the potential influence of non-competitive partners on the establishment of coopetitive relationships. Public institutions have been found to be initiators and enablers of coopetition in innovation networks (Freel 2003), and clients may deliberately initiate vertical coopetition (Eriksson 2008; Depeyre & Dumez 2010) or strengthen competition in the case of unexpected emergent coopetition (Fernandez & Le Roy 2015). Blanka and Traunmüller (2020) showcased how high-tech incubators can serve as intermediaries and matchmakers in partner searches that involve start-ups and established firms, while Czakon and Czernek (2016) revealed the importance of the reputation and legitimisation of a third party to build the trust necessary for competing companies to enter into network coopetition. Their study also reveals the need to enhance our understanding of the establishment of coopetitive collaborations by departing from the 'focal firm' perspective and exploring the other side of the coin – how companies invited to join such collaborations assess those opportunities.

The dominant starting point in the coopetition literature was the assumption that companies are in a position to choose other partners because many invited companies would accept an offer to collaborate (Lee, Park & Yoon 2016). A few studies have indicated that it is not always easy to attract partners and that we need more insights into the broad conditions that must be met for competitors to decide to engage in collaborations (Nemeh & Yami 2016). Some of the factors identified as important for the decision of companies to engage in inter-network coopetition in the limited number of studies that have been carried out are a favourable context, unified objectives, consistency with the firm's strategy and project portfolio (Nemeh & Yami 2016) and high prior experience in coopetitive collaborations, while less previous experience leads to engagement only within a firm's existing coopetitive network (Schiavone & Simoni 2011).

The standpoint adopted in this dissertation is that not all competing companies may be equally willing to join collaborations or equally successful in coping with their challenges (Yang 2020). To attract the best partners, enhance successful establishment that further influences the sustainability and outcomes of coopetitive collaborations, we need to understand the evaluation process carried out by competitors invited to joint such collaborations. This evaluation process is thoroughly analysed in Paper 1.

Partner selection has been recognised as only one of several factors necessary for successful coopetitive collaborations. In addressing the overarching aim of this dissertation, I have also explored the management of tensions as another success factor. An overview of existing research on such tensions follows in the next subsection.

2.2.4 On tensions in organisation and management research

Even though organisation theory has, from its earliest days, acknowledged that organisations deal with contradictory demands (e.g., Fayol 1990; Taylor 1911), classical organisation management, until the late 1980s, typically perceived oppositions as independent discontinuities that needed to be solved based on an either/or approach (Ballard-Reisch & Turner 2017). Following Quinn and Cameron's (1988) notion of paradoxes as sources of tensions affecting the management of organisations, Poole and van de Ven's (1989) article was among the first to elaborate on the relevance of exploring the tensions, oppositions and contradictions based on a both/and logic that would provide more comprehensive explanations of the phenomenon and novel encompassing theories. According to these authors, the multifaced reality that is characteristic of most organisations cannot be completely captured by focusing only on consistencies. This perspective, if relatively new in organisation and management research, had early advocates in other fields, such as philosophy (e.g., Søren Kierkegaard and Charles Hampden-Turner) and psychology (e.g., Sigmund Freud and Gregory Bateson), among others (Lewis & Smith 2014).

After Poole and van de Ven's article (1989) article, a growing body of organisation and management literature shifted from the trade-off view on organisational divergences perceived as anomalies to the paradox view, which accepts coexisting contradictions as a regular part of organisational life (Trethewey & Ashcraft 2004). Scholars have also argued that each era has 'symptomatic' tensions (Putnam, Fairhurst & Banghart 2016) that can also be viewed as drivers for adaptation and constructive change (Lewis 2000; Wannags & Gold 2020). The pervasive research interest in tensions in the organisation and management fields over the last three decades has been driven by the need to adapt to increasingly complex organisational environments shaped by globalisation, technological innovation, changing economic conditions and high competitive pressures (Margolis & Walsh 2003; Putnam, Fairhurst & Banghart 2016; Smith & Tushman

2005). Numerous organisational tensions have recently come into focus, such as short-term versus long-term corporate orientations, isomorphism versus structural and technological change and efficiency versus resilience (Hahn et al. 2015, p. 304), exploration versus exploitation (Smith & Tushman 2005) – also referred to as the ambidexterity challenge (Tushman & O'Reilly 1996) – innovation and change versus stability and collaboration versus control (Andriopoulos & Lewis 2009; Raisch et al. 2009; Revilla & Rodríguez-Prado 2018).

Even though we are witnessing this increasing research interest, numerous terms and definitions have been used interchangeably to explain the divergences that organisations face, and organisation and management scholars are still trying to achieve better conceptual clarity (Putnam, Fairhurst & Banghart 2016; Smith et al. 2017). Some of the terms often used interchangeably are 'tensions,' 'paradoxes,' 'dilemmas,' 'trade-offs,' 'dualisms,' 'contradictions' and 'dialectics' (Ballard-Reisch & Turner 2017; Haffar & Searcy 2017; Putnam, Fairhurst & Banghart 2016; Smith et al. 2017; Wannags & Gold 2020). This lack of clarity, particularly as it relates to the terms 'tensions' and 'paradox,' has been reported by numerous scholars. Putnam, Fairhurst and Banghart (2016), for instance, state that 'tension, however, is often the broadest, most ambiguous of the concepts, and the one that scholars frequently use to signify all paradoxical dynamics' (p. 68).

The lack of conceptual clarity in the organisation and management literature makes establishing a working distinction between 'tension' and 'paradox,' which is relevant for this dissertation, particularly challenging. Therefore, in Table 3, I first present some definitions of the most commonly used terms – 'tension,' 'paradox,' 'dilemma,' and 'trade-off' (Haffar & Searcy 2017) – before presenting my perspective.

Table 3: Definitions of most commonly used terms in the organisation and management literature

Term	Definitions	
Tension	1)	'Two phenomena in a dynamic relationship that involve both competition and complementarity' (Epstein, Buhovac & Yuthas 2015, p. 3).
	2)	A paradoxical relationship between two poles of a paradox (Hahn et al. 2015).
	3)	'Tensions: the underlying sources of paradox. Paradoxical tensions are perceptual – that is cognitively or socially constructed – polarities that mask the simultaneity of conflicting truths. Unlike dilemmas or either/or choices, paradoxical tensions signify two sides of the same coin' (Lewis 2000, p. 761).
	4)	'Stress, anxiety, discomfort, or tightness in making choices, responding to, and moving forward in organizational situations' (Putnam, Fairhurst & Banghart 2016, p. 69).
	5)	Stress and dilemmas caused by discontinuities, competing directions and opposite forces (Fairhurst & Putnam 2014).
	6)	Tensions perceived as a natural part of organisational life, experienced by organisational members and something to 'live with' rather than a problem to solve (Trethewey & Ashcraft 2004).
	7)	'A paradox consists of two poles, which when regarded individually, appear reasonable, but form an illogical relationship when taken together. This relationship between the two poles is defined as tension. A paradox persists over time' (Wannags & Gold 2020, p. 4).
Paradox	8)	'Contradictory yet interrelated elements that exist simultaneously and persist over time' (Smith & Lewis 2011, p. 382).
	9)	'Paradoxes denote tensions that coexist and persist overtime' (Smith 2014, p. 1592).
	10)	'Paradox: The tensions between clarity and uncertainty, the 'self-contradictory' nature of individual emotions and organizational action, are constantly present in any process that attempts to deal with change' (Vince & Broussine 1996, p. 7).
	11)	'This study … treats paradoxes and contradictions as inherent conditions and consequences of organizational change that should be integrated in change management practices … this paper calls for an open recognition of the intrinsic contradictory and paradoxical nature of organizational change' (Leclercq-Vandelannoitte 2013, p. 558).
	12)	'Paradox: Some 'thing' that is constructed by individuals when oppositional tendencies are brought into recognizable proximity through reflection or integration' (Ford & Backoff 1988, p. 89).
Dilemma	13)	'A dilemma implies that choosing one alternative will gain in some aspects, while losing something of equal value' (Olsen, Kruke & Hovden 2007, p. 75).

	14)	‘A dilemma denotes a tension such that each competing alternative poses clear advantages and disadvantages. Resolving the dilemma involves weighing pros and cons’ (Smith & Lewis 2011, p. 386).
Trade-off	15)	‘Situations where a sacrifice is made in one area to obtain benefits in another … whereby it is usually impossible to optimise them, all at once’ (Haffar & Searcy 2017, p. 496).
	16)	‘Dilemmas and trade-offs represent specific situations in which to act means choosing either one path or another. Each decision pathway will neglect one pole, either completely (dilemma) or partially (trade-off)’ (Wannags & Gold 2020, p. 4).

Source: Classification of terms adopted from Haffar and Searcy (2017); definitions adopted from individual articles.

As illustrated by the definitions in Table 3, the distinction between ‘tensions’ and ‘paradoxes’ from ‘dilemmas’ and ‘trade-offs’ is relatively clear because the last two typically require a choice between alternatives. However, there is a lack of such a bright line between ‘tensions’ and ‘paradoxes,’ which are often used interchangeably or even to explain each other. Following the same logic, Wannags and Gold (2020), in one of the more recent literature reviews, argue that ‘tensions’ can be used for both tensions and paradoxes, as indicated in definition 7 in Table 3, while ‘trade-off’ can be used for both dilemmas and trade-offs (see definition 16).

Two important commonalities can be observed some – though not all – of the definitions of tensions and paradoxes presented in Table 3: 1) an acknowledgement that a ‘paradox’ consists of two opposite poles and that the relationship between those poles causes tension (definitions 2, 3, 7, 8 and 12); and 2) both ‘tensions’ and ‘paradoxes’ are considered a natural part of organisational life (definitions 6, 7, 8, 9, 10 and 11). Based on the observed commonalities, my view is that tensions are caused by divergences incorporated into paradoxes; therefore, tensions may be understood as manifestations of paradoxes. That might also explain at least some of the interchangeable use of these terms in the literature.

Several perspectives on paradoxes emerged in the literature: 1) paradoxes as inherent in systems (Clegg 2002), 2) paradoxes as based on social actions and interactions within the systems (Putnam, Fairhurst & Banghart 2016) and 3) paradoxes as both inherent and socially constructed (Smith & Lewis 2011). Some of the broad categories of paradoxes discussed in detail in Paper 2 are as follows: learning paradoxes manifested as tensions between the old and stable and the new,

innovative response to change; belonging paradoxes manifested as tensions between, for instance, individual and collective identity; organising paradoxes manifested as tensions between flexibility and control; and performing paradoxes caused by the divergent goals of different stakeholders (Lüscher & Lewis 2008; Smith & Lewis 2011).

The management of tensions has been recognised as one of the main determinants of an organisation's fate (Poole & van de Ven 1989), and managerial responses to paradoxical tensions differ depending on the static or dynamic perception of organisational systems (Smith & Lewis 2011). If organisational systems are perceived as static, tensions are considered accidental events that need to be resolved to bring the system back to equilibrium; meanwhile, if organisational systems are considered dynamic, opposing forces are perceived as inherent and in constant motion, with sustainability achieved by continuous cyclical managerial responses (Smith & Lewis 2011). The managerial strategies suggested by Poole and van de Ven (1989) are acceptance, which implies embracing the paradox and living with it, and resolution, which involves addressing divergent demands based on three strategies: spatial separation of dualities between different business units, temporal separation along different points in time and synthesis, which simultaneously accommodates both sides. By introducing the dynamic equilibrium model, Smith and Lewis (2011) indicate that latent organisational tensions become salient due to the complexity of the external environment, change, plurality, scarcity and actors' paradoxical cognition and reaction. Managerial strategies suitable for managing salient tensions are: 1) acceptance of the paradoxes based on a 'working-through strategy' enhanced by individuals being able to apply paradoxical thinking and dynamic organisational capabilities and 2) a 'paradoxical resolution' based on iterative splitting and integration (Smith & Lewis 2011, p. 389).

Paradoxes have often been discussed at the organisational level, even if they are also acknowledged at the intra- and inter-organisational levels (Smith & Lewis 2011; Wannags & Gold 2020). The coopetitive tensions specifically explored in this dissertation have been discussed at both the intra- and inter-organisational levels (Raza-Ullah, Bengtsson & Kock 2014).

2.2.4.1 Tensions in the coopetition literature

The term ‘tensions’ is widely used in the coopetition literature, often interchangeably with ‘conflicts,’ ‘paradoxes,’ ‘risks’ and various types of problems. There are numerous views on the classification of tensions. However, two broad perspectives require further explanation since they differ in their understanding of the sources of tensions and the appropriate management styles to deal with them: 1) tensions perceived as conflicts (Bouncken et al. 2020; Tidström 2014) and 2) tensions perceived as the manifestation or result of the coopetition paradox and thus rooted in the need for simultaneous collaboration and competition (Bengtsson & Kock 2014; Bengtsson, Raza-Ullah & Vanyushyn 2016; Czakon, Fernandez & Minà 2014; Raza-Ullah 2020; Stadtler & van Wassenhove 2016).

The first perspective perceives tensions as forms of conflicts between competing companies (Bouncken, Fredrich & Kraus 2020). Adhering to this stream, Tidström (2014) defines tensions as ‘situations of conflict occurring in coopetitive relationships … therefore, the terms tension and conflict are used interchangeably’ (p. 262). Later on, Tidström (2018) clarifies that ‘conflicts in coopetition are related to each other, and may together reflect a tension. Accordingly, literature on conflict and conflict management is applicable when exploring tension’ (p. 150). Similarly, drawing on Fang, Chang and Peng (2011, p. 774), Bouncken et al. (2020) define tension as ‘two co-existing contradictory forces with conflicting goals’ (p. 651), indicating that conflict determines tensions. The main focus of this view of tensions is on potentially opportunistic threats (Osarenkhoe 2010) that imply the need to either attack or defend one’s own position. Various sources of conflicts have been identified. Tidström (2009), for instance, distinguishes between organisational sources of conflicts, which may be normative or operational, relational sources of conflicts that may be strategic or normative and external sources of conflicts related to other actors. Bouncken et al. (2020) note the importance of prompt identification of relationship conflicts, task-related conflicts and value distribution-related conflicts to achieve the value-creation-capture equilibrium in new product development alliances. In the case of vertical coopetition, task-related or cognitive conflicts may be functional, while relationship-related or affective conflicts may appear to be dysfunctional (Rajala & Tidström 2021; Tidström & Rajala 2016). Scholars applying this perspective

build on the conflict management literature and examine the applicability of various conflict management styles: competition, which leads to win-lose solutions; collaboration, which provides win-win solutions; compromise, which is based on mutual concession; avoidance, which is based on suppressing or denying tensions; and accommodation, which benefits one side to the detriment of the other (Thomas & Kilmann 1974). As indicated by Tidström (2018), the vertical or horizontal nature of coopetitive relationships may influence the appropriate conflict management style. Competition and avoidance have been identified as the most commonly used management styles in horizontal coopetition (e.g., Tidström 2009, 2014). In vertical coopetition, collaboration was identified as dominant, although in some cases accommodation and compromise were also applicable (Rajala & Tidström 2016). Bouncken et al. (2020) indicate that partners with greater expert power may have the most prominent influence on conflict management style. One of the criticisms of this understanding of tensions that has been noted in the literature is that it may overestimate the competitive as opposed to cooperative aspects of relationships or consider cooperation a constant which, due to the dynamic nature of coopetition, may not reflect reality (Raza-Ullah 2020).

The second perspective on tensions explains both competitive and cooperative dimensions, arguing that tensions emerge from the coopetition paradox (Bengtsson, Eriksson and Wincent 2010; Bengtsson, Raza-Ullah and Vanyushyn 2016; Fernandez, Ji & Yami 2014). This stream builds on Smith and Lewis's (2011) definition of a paradox as 'contradictory yet interrelated elements that exist simultaneously and persist over time' (p. 382). Ansari, Garud and Kumaraswamy (2016) define tensions as 'the contradictory pressures that exists between the focal firm and other interdependent firms due to the presence of simultaneous forces for competition and cooperation' (p. 1830). Therefore, tensions are perceived as inevitable parts of coopetitive relationships that do not need to be eliminated; rather, they should be kept at a moderate level to ensure appropriate coopetitive performance (Bengtsson, Raza-Ullah & Vanyushyn 2016; Fernandez & Le Roy 2015; Fernandez, Le Roy & Chiambaretto 2018; Fernandez, Le Roy & Gnyawali 2014; Gnyawali et al. 2016; Raza-Ullah, Bengtsson & Kock 2014). According to this perspective, the coopetition paradox can manifest or result in tensions at the inter-organisational level between companies (e.g., Bengtsson, Eriksson & Wincent 2010; Fernandez & Chiambaretto 2016; Fernandez, Le Roy &

Chiambaretto 2018; Fernandez, Le Roy & Gnyawali 2014; Le Roy & Fernandez 2015), at the organisational level as tensions between the business units within a company (e.g., Chiambaretto, Massé & Mirc 2019) or at the individual level, depending on how individuals experience the coopetition paradox at the inter-organisational level (e.g., Bez et al. 2015; Raza-Ullah 2020). A brief overview of the paradox perspective on tensions and management styles for each of these levels follows.

Considerable research attention has been paid to the materialisation of the coopetition paradox and the management of tensions caused by it at the inter-firm level (Fernandez, Le Roy & Gnyawali 2014; Pellegrin-Boucher, Le Roy & Gurău 2013; Raza-Ullah 2020). These tensions are rooted in the need for simultaneous collaboration and competition; in other words, the inherent contradictions of coopetition (Devece, Ribeiro-Soriano & Palacios-Marqués 2019) such as value creation and appropriation and simultaneous knowledge sharing and knowledge protection (Gast et al. 2019; Jarvenpaa & Majchrzak 2016; Morris, Kocak & Özer 2007). Value creation and value appropriation tensions appear since competitors jointly create a 'pie' that is far larger than their individual contributions (Brandenburger & Nalebuff 1996) and try individually to capture an asymmetrical piece of that pie (Chiambaretto, Maurice & Willinger 2020). Those tensions were first analysed in a linear sequence (create then capture) and more recently in a more complex iterative sequence where both anticipated and achieved value appropriation constantly affect value creation (Bouncken et al. 2017; Ritala & Hurmelinna-Laukkanen 2018). Knowledge sharing tensions appear because knowledge flows are crucial for value creation and the success of coopetitive collaborations, even as knowledge represents a source of companies' competitive advantage that requires appropriate protection (Ritala, Kraus & Bouncken 2016; Rouyre & Fernandez 2019). Some factors may strengthen the intensity of knowledge sharing and protection tensions are higher competitive overlap and complementarity of capabilities (Dussauge, Garrette & Mitchell 2000) and greater ambiguity and weak intellectual property mechanisms (Ritala & Hurmelinna-Laukkanen 2013). Lastly, Pellegrin-Boucher, Le Roy and Gurău (2013) found vertical coopetitive relationships to be more stable, with a lower level of inter-organisational tensions and greater potential to last, while horizontal coopetitive relationships typically bear higher risks and a higher level of inter-organisational tensions.

In contrast to conflict management styles suggested by the conflict perspective on tensions, the paradox perspective suggests the management of inter-organisational tensions through different structuring and organisation principles, different governance modes and varying protection mechanisms. An explanation of each management style follows. Three organisational principles have been explored in the coopetition literature: integration, separation and co-management (Fernandez & Chiambaretto 2016; Fernandez, Le Roy & Gnyawali 2014; Le Roy & Czakon 2016). The integration principle corresponds to acceptance of the coopetition paradox (Le Roy & Fernandez 2015; Lewis 2000; Smith & Lewis 2011) and simultaneous management of both the competition and cooperation sides of that paradox (Bengtsson, Raza-Ullah & Vanyushyn 2016; Chen 2008; Das & Teng 2000; Smith & Lewis 2011). The separation principle is based on keeping competition and cooperation apart in terms of space, time or company level or unit (Bengtsson & Kock 2000; Dowling et al. 1996), while Le Roy and Fernandez (2015) revealed a new co-management principle appropriate for common coopetitive project teams, collocated at the same place but separated from competing companies and managed based on dual and equally shared governance. The co-management principle is therefore relevant for the working-group level and combines both integration at the individual level and separation at the organisational level (Fernandez, Le Roy & Chiambaretto 2018; Le Roy & Fernandez 2015). As to structure, Fernandez, Le Roy and Chiambaretto (2018) have found that a common coopetitive project team is appropriate for managing tensions in high-risk and high-cost radical innovation projects, while separated project teams that are located in each of the competing companies and who perform tasks independently based on limited interactions and a limited level of cooperation and competition between competitors, are suitable for managing tensions in low-cost and low-risk incremental innovation projects. However, Rouyre and Fernandez (2019) reported that the common coopetitive project team approach does not suit radical innovation projects between multiple competitors. The management of tensions in this type of project requires a centralised project team, in which competitors separated in different work packages communicate through the mediation of a third party (Rouyre & Fernandez 2019).

As indicated above, inter-organisational tensions caused by the coopetition paradox may also be managed by different governance modes. Scholars have argued that the type of knowledge created in coopetitive collaborations, the level

of technological turbulence and the type of innovation may all help determine the choice among internal, co-operative, contracting or joint venture modes of governance (Cassiman, di Guardo & Valentini 2009; Hung & Chang 2012) or, from a broader perspective, transactional or relational governance or a combination of those two modes (Bouncken, Clauß & Fredrich 2016). Lastly, inter-organisational tensions may be managed based on different protection mechanisms. For instance, when managing information tensions between competitors, formal control mechanisms have been found necessary to differentiate between critical and non-critical information, and the handling critical information requires using both formal and informal mechanisms (Fernandez & Chiambaretto 2016). Similarly, Gast et al. (2019) indicate the relevance of combining formal and informal mechanisms to deal with knowledge sharing and protection tensions. Additionally, information systems and digital technology have recently been recognised as enablers of more efficient knowledge sharing (Bouncken & Barwinski 2021; Fernandez & Chiambaretto 2016; Randolph, Hu & Silvernail 2020), while d'Armagnac, Geraudel and Salvetat (2019), for instance, indicate the need for different sharing and protection mechanisms in temporary coopetitive relationships, like projects, as opposed to alliances and long-term collaborations. An emerging perspective that requires more research attention (Chou & Zolkiewski 2017; Tidström, Ritala & Lainema 2018) suggests the possibility of mediated management of inter-organisational tensions by third parties that may facilitate knowledge sharing (Rouyre & Fernandez 2019), trust and better collaborative interactions (Castaldo et al. 2010; Depeyre, Rigaud & Seraidarian 2018; Fernandez & Pierrot 2016; Madhavan, Gnyawali & He 2004; Tidström, Ritala & Lainema 2018). Fernandez and Pierrot (2016) and Fernandez and Le Roy (2015) also warn that in addition to positive outcomes, there might be negative influences of third parties that could even cause tensions and a redistribution of the power in coopetitive relationships. Lastly, at the inter-organisational level, scholars have mainly explored coopetitive tensions in alliances (Bouncken, Clauß & Fredrich 2016; Bouncken et al. 2017; Kim & Parkhe 2009) and networks (Bengtsson & Kock 2000; Madhavan, Gnyawali & He 2004), while the relevance of coopetitive innovation projects has begun to be recognised more recently (Fernandez & Chiambaretto 2016; Fernandez, Le Roy & Chiambaretto 2018).

According to the paradox perspective, the coopetition paradox can also result in the tensions at the organisational and individual levels (Devece, Ribeiro-Soriano & Palacios-Marqués 2019; Fernandez et al. 2014; Raza-Ullah, Bengtsson & Kock 2014). Organisational-level tensions are related to internal coopetition; that is, simultaneous collaboration and competition for resources between different business units within a company (Arvidsson 2009; Chiambaretto, Massé & Mirc 2019; Tsai 2002). Tsai (2002) found a negative influence of formal and a positive influence of informal interactions on knowledge sharing between coopetitive business units. As indicated by Seran, Pellegrin-Boucher and Gurau (2016), an integration strategy may also be relevant for managing those tensions through the simultaneous use of formal and informal coordination mechanisms, the establishment of cross-unit projects and the enhancement of horizontal coordination, social interaction and trust. Chiambaretto, Massé and Mirc (2019) revealed the role of knowledge brokers, who may foster knowledge sharing and trust while simultaneously protecting the competitive advantage of business units. Scholars agree that this type of intra-organisational tension remains largely unexplored and requires more attention (Gernsheimer, Kanbach & Gast 2021).

Lastly, individual-level tensions resulting from the coopetition paradox have been explored at the managerial and employee level (Gnyawali & Park 2011a; Raza-Ullah, Bengtsson & Kock 2014). Raza-Ullah (2020) defines this kind of tension as 'the cognitive difficulty experienced by managers when they pursue multiple and simultaneous contradictory demands that are inherent in coopetition' (pp. 3–4). Stadtler and van Wassenhove (2016) also indicate the importance of employees' understanding and sense-making processes when navigating emerging tensions. The way managers experience and evaluate the coopetitive paradox at the inter-organisational level – and its consequences for the company – creates internal tensions driven by their emotional ambivalence (Bengtsson, Raza-Ullah & Vanyushyn 2016; Raza-Ullah 2017; Raza-Ullah, Bengtsson & Kock 2014). Furthermore, strategic decisions are often made by senior managers, and other employees may not share the same understanding (Bengtsson, Raza-Ullah & Vanyushyn 2016). Therefore, inter-organisational tensions may spill over to lower levels of organisations due to different views among the various managerial and employee levels on the benefits and drawbacks of coopetitive relationships with other companies (Raza-Ullah, Bengtsson & Kock 2014; Stadtler & van Wassenhove 2016). The development of managerial coopetition capabilities has

been proposed as a way to deal with these tensions; it is defined as 'the ability to think paradoxically and to initiate processes that help firms attain and maintain a moderate level of tension, irrespective of the strength of the paradox' (Bengtsson, Raza-Ullah & Vanyushyn 2016, p. 19). Gnyawali et al. (2016) emphasise the importance of analytical capabilities for a proper understanding of the coopetition paradox, the related tensions and their sources and execution skills; these capabilities are required for the development of appropriate mechanisms, routines and management styles to address tensions efficiently and promptly. Bez et al. (2015) point out the critical role played by managers, since different managers may integrate the coopetition paradox in different ways: completely or partially and with or without cognitive recognition (i.e., consciously, unconsciously or in a hidden fashion). Similarly, Stadtler and van Wassenhove (2016) suggest the relevance of the integration principle at the employee level, which may mean prioritising collaboration over competition or vice versa without ignoring either pole entirely. Some scholars have also noted the importance of a hierarchical organisational structure and formalisation and standardisation for mitigating internal tensions (Klimas 2016) or informal internal mechanisms that enhance internal loyalty, trust and commitment (Gast et al. 2019).

This dissertation adopts the paradox perspective on tensions. Therefore, in Paper 2 tensions are considered to be manifestations of the coopetition paradox and its underlying divergences, such as the learning, performing, organising and belonging paradoxes (Smith & Lewis 2011), explored at both the inter- and intra-organisational levels. The thesis also examines paradoxical resolutions like 'managerial strategies that support contrasting elements simultaneously' (Smith & Lewis 2011, p. 396): acceptance via a 'working-through' strategy and iterations of splitting and integration strategies (Smith & Lewis 2011) for managing the tensions at both levels.

2.3 The research and development phenomenon

A widely acknowledged publication that has defined R&D and explained its nature, components and boundaries for more than half a century is the OECD's *Frascati Manual* (2015). The main aim of the manual is to enable the common understanding, measurement and interpretation of data regarding R&D activities and thus provide guidance for academics, practitioners and policy makers. The first definition of R&D was provided in in the 1963 edition of the manual (OECD 2015)

and has since been revised numerous times (Djellal et al. 2003). According to the latest version, published in 2015, 'research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge' (OECD 2015, p. 44).

Several aspects of R&D activities have been clarified by the OECD's *Frascati Manual*. First, to be considered R&D, an activity has to be simultaneously novel and creative, uncertain in terms of outcomes and the time or resources needed, systematically planned, transferred or traded and reproducible (OECD 2015, p. 45). Second, R&D activities may result in new fundamental knowledge about a certain phenomenon without its simultaneous application (i.e., basic research), new practical knowledge that may be directly employed (i.e., applied research) or new, systematically obtained research and practical knowledge that enables the development of new or the improvement of old products, services or processes (i.e., experimental development; OECD 2015, p. 45). The OECD manual classifies R&D activities that enhance the way that new or improved products, processes and services are brought to market i.e. lead to innovation, as part of innovation activities. This perspective has been applied in this dissertation.

2.3.1 Research and development management evolution

When discussing R&D as part of innovation activities, the management literature recognises that, on one hand, R&D activities may significantly support innovation and consequently enhance the market and competitive positions of companies and, on the other, are very often perceived as uncertain, risky and challenging for companies (Demirel & Mazzucato 2012; Mairesse & Mohnen 2004; Miles 2007; Miller 2015). The management of R&D activities has evolved over the years, and scholars identify several generations characterised by different R&D processes and managerial approaches, although different scholars use slightly differently start and end dates. For instance (Miller 2015), distinguished four generations based on dominant R&D capabilities and architectures providing competitive advantage. The first generation, from 1900 to 1940, was characterised by internal R&D laboratories and the development of internal capabilities. The second, which ran from 1940 to 1975, focused primarily on costs and the scope of innovation within companies, though it also saw the introduction of R&D collaboration with universities and R&D organised through multidisciplinary

projects. The third generation, from 1975 to 2000, was characterised by high-quality products and services at lower costs; internal R&D and collaboration with universities was complemented by technology licensing, collaborations with partners or acquisitions supported by digital tools, portfolio management and technology roadmaps and technology platforms. The fourth generation, which began in 2000, comprises tangible and non-tangible assets and layered architecture, while the scope of R&D is much broader and more closely integrated with innovation. The first three generations were mainly oriented towards the discovery of technical knowledge and technological transfer, following the linear model of research that does not typically progress from development to commercialisation. The fourth generation follows a non-linear, iterative model and 'combines knowledge, tools, and processes in business models' (Miller 2015, p. 3) to address technological uncertainty, leverage external partnerships based on improved internal capabilities and develop new external capabilities to address market needs. Table 4 summarises another classification of five generations and the anticipated characteristics of the sixth generation; it is adapted from Nobelius (2004, p. 2).

Table 4: Evolution of R&D management processes

Generations and time periods	**Characteristics of R&D processes**	**Organisation**
First generation (1950 to the mid-1960s)	R&D as linear technology pushing process aimed at scientific breakthroughs; more R&D results in more products; limited interaction with the rest of the company.	Corporate labs
Second generation (mid-1960s to early 1970s)	R&D driven by market and internal customers, guided and controlled by project management.	Business units
Third generation (mid-1970s to mid-1980s)	Linked process- and interaction-focused R&D for internal technology development at minimised costs.	R&D projects linked to business and corporate strategies, portfolio and project management
Fourth generation (early 1980s to mid-1990s)	R&D moving from a product focus to a total business concept focus.	Cross-functional projects involving suppliers and lead customers
Fifth generation (mid-1990s through today)	R&D in interaction with competitors, customers, suppliers; focus on coordination and integration of various systems; separation of R&D dilemmas; integration of technology and product development.	Inter-organisational alliances and networks
Sixth generation Future	Increasingly complex R&D due to challenging integration of various aspects; increased technological and actor complexity.	Multi-partner ecosystems, networks alliances, projects

Source: Adapted from Nobelius (2004, p. 2).

As discussed above, the increased complexity of industrial, market, technological and environmental conditions led to a shift in orientation from internally organised R&D to collaborative R&D, first across different organisational units withing the same company and then across organisational boundaries and ultimately involving a variety of partners, beginning with customers and suppliers and moving to universities and eventually competitors (Belderbos et al. 2004; Cassiman, di Guardo & Valentini 2009; López 2008; Smith 2012). In an increasingly distributed and collaborative approach to innovation, the general transition from manufacturing to more service-oriented business models also led to a growing orientation towards collaborative, externally sourced and more globalised R&D activities (Howells 2008).

Scholarly debates following this evolution have explored the relevance of complementing internal with external R&D for various types of innovations, noting, for instance, its greater relevance to product innovation than to process innovation (Krzeminska & Eckert 2016) and the influence of firm size rather than type of industry on engagement in collaborative R&D (Belderbos et al. 2004; Fritsch & Lukas 2001; Kleinknecht & Reijnen 1992; López 2008; Miles 2007), indicating that large firms may be more prone to engage in collaborative R&D, whereas smaller firms may suffer from insufficient absorptive capacity and a lack of the internal capabilities necessary to benefit from collaborative R&D and also raising the question of appropriate governance types (Suh & Kim 2012; Teirlinck 2017; Teirlinck & Spithoven 2011, 2013).

Scholars have also pointed out the importance of the willingness of partners to share knowledge and information for successful collaborative R&D (Geum et al. 2013). Different R&D partnerships may bring different benefits, not all of which improve a company's innovation performance (Du, Belderbos & Leten 2020; Miotti & Sachwald 2003; Ren et al. 2006; Santamaría & Surroca 2011). Market and research partners have important but different roles in R&D projects and generate different types of knowledge (Hamadi, Leker & Meerholz 2018; Hoang & Rothaermel 2005). Collaboration with research partners carries lower risks and costs, resulting in scientific and technological knowledge (Tether 2002) that may enhance firms' technological competitiveness and innovation performance (Belderbos, Gilsing & Suzuki 2016). R&D collaboration with market-based partners is accompanied by higher risks and provides specific market knowledge helpful in solving problems, entering new markets and satisfying customers' needs (Du, Leten & Vanhaverbeke 2014). Furthermore, collaborations with universities and customers have proven beneficial for more radical innovations, while R&D collaborations with competitors and suppliers has proven beneficial for incremental innovations (Belderbos et al. 2004; Ritala & Sainio 2014). Therefore, selecting appropriate partners is essential and may be based on numerous criteria, such as the possession of certain resources (Reuer & Devarakonda 2017), the alignment of technology roadmaps (Lee, Park & Yoon 2016), the tangibility of collaborative outcomes (Borch & Solesvik 2016) and the strength of value creation abilities (Diestre & Rajagopalan 2012).

Lastly, as indicated in the so-called sixth generation of R&D management, we are now witnessing increasing research interest in complex R&D collaborations

involving multiple partners–science partners, suppliers, customers and competitors – that have been recognised as a way to address costly and time-consuming technological challenges and deal with dynamic business environments (Jakobsen 2020; Yang 2020). There are both benefits and downsides of multi-partner R&D collaborations. The involvement of a wide range of partners may enhance a project's benefits. For instance, the presence of non-competitors such as customers may improve the synergies and integration of similar knowledge and technology of competing companies, enhance the impact of collaborations between research partners and competitors and increase market acceptance (Ren et al. 2006; Yang 2020). Furthermore, Chen, Dai and Li (2019) indicate that the involvement of market competitors and suppliers, universities and customers significantly affects interactions in consortia and forms U-shaped relationships with joint R&D results. Multi-partner R&D collaborations also face numerous managerial challenges that increase the risks of failure (Bäck & Kohtamäki 2015; Lhuillery & Pfister 2009; Lim, Chesbrough & Ruan 2010), such as increased relational complexity, intense knowledge sharing and protection issues (Rouyre & Fernandez 2019) and coopetitive tensions, organisational and integrational issues (Barbic, Hidalgo & Cagliano 2016; Du et al. 2020; Henttonen, Hurmelinna-Laukkanen & Ritala 2016; Ritala et al. 2017). To mitigate challenges and enhance the benefits of multi-partner R&D projects, scholars have investigated the appropriate project organisation (Mishra, Chandrasekaran & MacCormack 2015), relational or contractual modes of governance, (Barbic, Hidalgo & Cagliano 2016; Du et al. 2020), knowledge sharing and integration mechanisms and management of tensions (Henttonen, Hurmelinna-Laukkanen & Ritala 2016; Santos, Soares & Carvalho 2012). Communication and coordination are also of particular importance for knowledge sharing and innovation outcomes (Olander et al. 2010) in multi-partner R&D projects (Bogers 2011; Hamadi, Leker & Meerholz 2018).

Therefore, there is no single best way to successfully manage increasingly complex R&D collaborations, so scholars have sought insights into the day-to-day management of those collaborations in varying contexts (Dietrich et al. 2010; Du et al. 2020; Lin & Yang 2020; Plewa & Quester 2006; Yang et al. 2020). This dissertation contributes to those calls by exploring coopetitive R&D and innovation collaborations that include both competitive and non-competitive partners. This complex setting has proven valuable for obtaining new insights into the roles and interactions of all partners (Papers 1 and 3).

2.4 The context of mature and manufacturing industries

The empirical context explored in this dissertation is mature manufacturing industries. A general classification of industrial maturity phases is presented first, followed by an overview of the specifics of innovation processes and collaborations for innovation in mature industries and insights regarding the manufacturing industries.

2.4.1 The peculiarities of innovation processes in mature industries

As Strebel (1985) indicates, not all industries evolve in the same way, but the emergence, growth, maturity and decline phases are common to most of them. Certain innovation characteristics are typical of each phase (Strebel 1985). Emerging industries are newly formed industries 'pushed' by technological shifts, new customer needs or other economic or social changes in the broader business environment (Calori 1985). Frequent and fundamental product innovation is crucial for the survival of these industries at this stage (Strebel 1985). During the growth phase, companies' strategies move from products towards a more process-oriented approach, with a focus on cost reduction that, together with standardised products, is of crucial importance to price competition (Dosi & Nelson 2013). Mature industries have passed the growth phase but have not reached the decline phase (McGahan & Silverman 2001). Since technology and markets also mature, in this phase companies need to reach new markets and use a variety of knowledge sources in order to innovate (Laursen & Salter 2006). Therefore, incremental market-driven innovation and differentiation strategy are typical of this phase. The decline phase is characterised by the greatest competitive pressure, and fundamental product or process innovation is required to survive (Strebel 1985).

Most empirical studies about collaborative innovation, particularly coopetition for innovation, have been conducted in the context of emergent industries (Pellegrin-Boucher, Le Roy & Gurău 2018). Those industries have been recognised as first adopters of OI practices (Chesbrough & Crowther 2006), and scholars have noted differences in innovation propensity and knowledge used in emergent as opposed to mature industries (Chiaroni, Chiesa & Frattini 2010; Bodas Freitas, Argou Marques & de Paula Silva 2013). Therefore, the insights into

innovation practices we have from emergent industries may not be readily transferable in mature industries.

Certain characteristics of coopetition for innovation in mature industries require further elaboration. For instance, in line with the general characteristics of specific industry phases, scholars have found that differences in market conditions in emergent and mature industries significantly influence the type of collaborative innovation. Stronger market turbulence and competition largely based on technology and product development lead to more radical innovation in emergent industries, while lower levels of market turbulence and competition based largely on costs often lead to more incremental innovations in mature industries (Bodas Freitas, Argou Marques & de Paula Silva 2013).

Next, the shift from a product- towards a more process-oriented strategy forces companies in mature industries to search for different knowledge sources for innovation (Laursen & Salter 2006). Companies in mature industries tend to rely more on employees' tacit knowledge and often face challenges when incorporating knowledge from external actors (Chiaroni, Chiesa & Frattini 2010; Ciravegna & Maielli 2011). Therefore, scholars acknowledge that finding the appropriate balance between internal and external knowledge sources is not always straightforward in mature industries (Caiazza 2015; Chiaroni, Chiesa & Frattini 2010). The transition from closed innovation practices to OI in mature industries requires changes in organisational structures and processes and internal practices to incorporate external knowledge (Chiaroni, Chiesa & Frattini 2010; Ciravegna & Maielli 2011). The need to open up for collaborative innovation has become clear today, when mature industries are faced with increased technological pressures, and technological change is necessary to maintain existing markets and enter new ones (Onufrey & Bergek 2020).

When it comes to collaboration partners, scholars have found that coopetitive collaborations become inevitable at a certain point (Bonel & Rocco 2007) and that advanced industrial maturity combines with increased costs and shrinking markets to stimulate even stronger competition between companies (Mathias et al. 2018; Tidström & Rajala 2016). Under those conditions, sustaining coopetitive innovation relationships in the long run becomes especially important. According to Bonel and Rocco (2007), coopetition strategies require adjustments of firms' business models in line with their emerging interrelations with competitors. Collective identity and collective norms have been found to be of particular

importance for sustainable coopetitive collaborations (Mathias et al. 2018), and Jakobsen (2020) discusses the relevance of structural dependence between companies in the early stages and psychological dependence in the later stages of the alliance lifecycle. Formal coopetition strategies have been identified as important for capturing value at the firm level in the case of mature small- and medium-sized enterprises (SMEs; Bouncken et al. 2020).

Lastly, the context of mature industries may affect knowledge creation and dissemination in R&D projects (Du, Leten & Vanhaverbeke 2014). The aim of collaboration with research partners in emergent industries is new knowledge generation, while the goal of this type of collaboration in mature industries is an improved integration of technology and embodied knowledge (Bodas Freitas, Argou Marques & de Paula Silva 2013). Collaboration with research partners in emergent industries is often established based on new informal contacts, whereas this type of collaboration in mature industries is often initiated by previous contacts (Bodas Freitas, Argou Marques & de Paula Silva 2013). Borch and Solesvik (2016) indicated that the benefits of collaborative R&D projects are not always visible in mature industries. Therefore, the immediate appeal of such projects for companies may be lower, and trust becomes of crucial importance for forming R&D collaborative partnerships (Solesvik & Encheva 2010).

2.4.2 Manufacturing industries

As defined by Schroeder, Scudder and Elm (1989), ‘innovation in manufacturing is the implementation of new ideas or changes, big or small, that have the potential to contribute to organizational (business) objectives’ (p. 6). Thirty-two years ago, these authors suggested the adaptation of organisational goals, structures, processes, cultures and resources as a way to improve innovation in this sector. Over the ensuing three decades, globalisation relentlessly challenged the ways that manufacturing firms operate and innovate, offering new knowledge sharing and innovation opportunities (Bailey et al. 2010). Rapidly changing technologies and shorter product lifecycles impose new requirements on manufacturing companies such as enhanced quality, lower costs and reduced pollution (Jakobsen 2020) in the transition from traditional manufacturing activities to a hybrid combination of manufacturing and services (Bailey et al.

2010). To address these demands, companies increasingly engage in various types of inter-organisational collaborations with a wide range of partners.

Coopetition is still rarely studied in manufacturing industries (Tidström & Rajala 2016), and some scholars have indicated that it offers lower benefits in manufacturing than in emergent high-tech industries (Nieto & Santamaría 2007). Technology, which is recognised as a source of core competitive advantage in manufacturing industries, may be particularly vulnerable to coopetitive dynamics and the changeable nature of roles in coopetitive relationships (Tidström & Rajala 2016). Therefore, companies in manufacturing industries may experience certain discrepancies between activities at the individual and firm levels that might affect coopetitive relationships at the inter-organisational level (Tidström & Rajala 2016).

Collaboration between competitors in manufacturing industries typically aims at cost reduction and increased resource efficiency, distribution, sales, increased market share and R&D innovation (Ritala, Golnam & Wegmann 2014; Ritala & Hurmelinna-Laukkanen 2009). According to Pereira, Leitão and Devezas (2017) internal innovation processes and resistance to external R&D services are two major limiting factors for manufacturing firms' co-innovation capacities in general. Those authors found that an organisation's internal structures, procedures and R&D appeared to have no influence, while innovation for the market and already established coopetitive relationships, especially coopetitive R&D collaborations, increase a firm's capacity for co-innovation. The way R&D investments are used is more important than the amount expended (Ettlie 1998). According to Becker and Dietz (2004), manufacturing firms tend to complement their internal R&D with external R&D cooperation, which enhances their overall R&D intensity and commitment. These authors further hold that heterogeneous partners increase the synergies, research productivity and likelihood of more radical product innovations in the manufacturing industries. For some manufacturing firms, such as SMEs, management of collaborative R&D becomes a crucial determinant of innovation to achieve the level of performance needed to stay competitive (Raymond & St-Pierre 2010). Cohen, Nelson and Walsh (2002) noted the crucial importance of university research for the manufacturing sector in two aspects: as a source of project ideas and as a source of knowledge for project completion. R&D collaborations have also been found to be vital for environmental innovations at manufacturing firms (De Marchi 2012).

Several factors have been found to be important for the establishment of R&D collaborations in manufacturing industries. High incoming spill-overs, well-regulated legal protection and appropriation all enhance the probability of R&D collaborations in general (López 2008). Cost and risk sharing was found to be the most important factor for R&D cooperation with universities, suppliers and customers, while high protection mechanisms are crucial for cooperation with competitors and may even hamper knowledge flows with other partners (López 2008).

Taken together, the specifics of mature manufacturing industries may pose certain challenges for the establishment and management of coopetitive R&D projects and thus present a particularly fruitful context for the research presented in this dissertation.

2.5 Project perspective

We have considerable knowledge about OI networks and alliances, especially at the firm level, and scholars have sought more insights into business-to business innovation projects (Gurca et al. 2021; Markovic et al. 2021; West & Bogers 2017). At the beginning of this PhD project, previous studies of OI projects were scant. However, in the last few months two special journal issues have been published to help address the gap (Keinz et al. 2021; Markovic et al. 2021). The timing of these publications serves as support for the view that the present study is making a timely contribution to knowledge.

The importance of the project perspective can be explained in several ways. The various conflicting and even contradictory findings, such as the positive, negative or neutral influence of OI on innovation performance, may be caused by a misleading firm perspective and conclusions made at the aggregate level (Du, Leten & Vanhaverbeke 2014). The editors of the special issue of *Industrial Marketing Management* published in April 2021 (Markovic et al. 2021) have illustrated the drawbacks of conclusions based exclusively on the firm perspective and emphasised the need to open the ‘firm-level black box’; they state that, for instance, when a company with a largely closed innovation orientation engages in only a few OI projects, we may credit the innovation performance achieved to its closed innovation orientation. However, specific OI projects should not be neglected since they may actually be the major difference.

Scholars have found that companies typically decide on collaboration opportunities based on a particular project's needs rather than by considering firm-level concerns (Lee et al. 2019). Therefore, various peculiarities of innovation projects need to be taken into consideration. According to Culpan (2014), there are different ties, goals and time perspectives in innovation projects than are found in alliances. Innovation projects are oriented towards short-term relationships with looser ties and precise goals, while alliances involve long-term, deeply embedded relationships that are often crucial for a company's innovation strategy in terms of pooling resources and capabilities. Innovation projects may be of different strategic importance for a single company and may lead to different types of innovation; they may thus require different types of knowledge and potential partners (Cassiman, Di Guardo & Valentini 2010; Kim, Kim & Lee 2015; Lee et al. 2019). The same company may behave differently in different projects in terms of technology, resources and project management styles (Bagherzadeh, Markovic & Bogers 2021; Cassiman, Di Guardo & Valentini 2010).

Firms typically innovate through R&D projects (Cassiman, Di Guardo & Valentini 2010). As defined by Du, Leten and Vanhaverbeke (2014), 'R&D projects can be considered as temporary entities that conduct a series of complex and interrelated activities with predefined goals' (p. 829). The intensified technological innovations we witness today bring with them increased costs and risks and the need for higher amounts of knowledge and resources than companies may be able to provide on their own; this may lead them towards engagement in R&D collaborations with external partners (Cho & Lee 2019; Ritala & Sainio 2014). Opening up R&D processes also helps companies achieve targets in a shorter timeframe than internal R&D activities (Lang, Tesch & Lindemann 2017). Dynamic capabilities have been recognised as a key factor in a company's ability to identify, source and leverage external knowledge and resources and engage in collaborative R&D projects (Keinz et al. 2021).

Selecting appropriate partners has been acknowledged as the single most important factor in a project's success (Bagherzadeh, Markovic & Bogers 2021). Guertler and Sick (2021) have developed a situational OI project management framework for identifying and selecting OI partners, while Bagherzadeh, Markovic and Bogers's (2021) framework supports most important early-stage managerial decisions related to openness for collaboration: choosing the appropriate type, selecting partner(s), identifying the internal firm practices

required and governing the collaboration. Collaborative innovation projects differ in uncertainty propagation (Gomes, Lopez-Vega & Facin 2021) and complexity and require different governance and OI mechanisms (Faems et al. 2008; Felin & Zenger 2014). The type of partner also influences project management practices. Du, Leten and Vanhaverbeke (2014) found that formal project management was not suitable for projects with science partners, and Barbosa et al. (2021) reported that formal planning accompanied by less bureaucracy increases performance in R&D projects with science partners.

Scholars have also reported several important issues related to value creation, knowledge sharing and system integration. Stefan, Hurmelinna-Laukkanen and Vanhaverbeke (2021) classified value creation tensions into manageable and non-manageable and those that create new tensions. Barbic et al. (2021) claim that value creation potential stimulates openness, but appropriation issues foster closeness. This can be solved in the interrelation between project and firm levels since perceptions at the project level can and generally do influence interpretations at the firm level. Managing interactions between individuals has been found to be particularly important in university-industry megaprojects (Locatelli et al. 2021). A company's internal procedures and actions also appeared to be very important for managing complex projects (Gurca et al. 2021); Du (2021) found that companies may avoid knowledge leaks and strategically distribute collaboration risks if they reveal only parts of their knowledge across different projects. R&D projects related to the company's non-core technological fields result in the greatest innovation benefits, whereas there is no difference between the risks and results of R&D projects in collaboration with market and science partners. Team diversity, resource allocation and opportunities all critically influence OI project performance (Cheah & Ho 2021; Tang, Fisher & Qualls 2021), and particular attention needs to be paid to OI management capability building that must pass through several complex phases (Melo et al. 2021). Lastly, OI intermediaries have been found very important for building dynamic OI capabilities and solving challenges in the initial project phase and for learning in the later project phases (Keinz & Marhold 2021).

Previous OI research has generally differentiated between projects with science partners and projects with market partners such as suppliers and customers (Du, Leten & Vanhaverbeke 2014). Research on coopetitive innovation projects is also emerging. While early coopetition studies focused on tensions in coopetitive

alliances in general (Gnyawali et al. 2016), more recent studies have begun to investigate tensions and their management at the innovation project level (Fernandez & Chiambaretto 2016). Scholars also agree that different coopetitive projects require diverse management practices, especially as to knowledge sharing and knowledge protection (d'Armagnac, Geraudel & Salvetat 2019). Furthermore, the management of coopetitive tensions is contingent on the risk profile of the innovation project, with high-risk projects requiring the establishment of a coopetitive project team and low-risk projects accommodating separated project teams (Fernandez, Le Roy & Chiambaretto 2018).

Despite the recent increase in research attention, some of the gaps that remain for further examination of collaborative innovation projects are related to project attributes apart from complexity and uncertainty and their influence on project performance and project management styles (Gurca et al. 2021). Of particular interest are factors related to characteristics and requirements (resources, partners, mechanisms) and the management of the various innovation project phases (Bagherzadeh, Markovic & Bogers 2021). It is also worth investigating projects with heterogenous partners instead of separately examining and comparing science- and market-based collaborations, the alignment of projects within overall project portfolios and the interrelations between various levels: project, firm and individual (Keinz & Marhold 2021; Locatelli et al. 2021).

Bearing these gaps in mind, this dissertation primarily focuses on coopetitive R&D projects that, following Du, Leten and Vanhaverbeke's definition (2014, p. 829), can be broadly defined as 'temporary entities involving two or more competing companies that together perform complex and interrelated activities with predefined goals'.

2.5.1 Project phases

The innovation management literature has recognised the importance of different project phases, especially the 'front-end' innovation phase (Nuno Castro & Pinto Ferreira 2020). However, there are a limited number of studies discussing business-to-business innovation projects, and OI scholars seek deeper insights into specific project phases (Bagherzadeh, Markovic & Bogers 2021; Keinz & Marhold 2021). The attention to project phases was significantly higher in the project management literature that distinguishes between initiation, planning, execution

or implementation and finalisation project lifecycle phases (Besner & Hobbs 2006). Scholars agree that leadership styles, project management practices and tools (Besner & Hobbs 2006; Ng & Walker 2008), change management activities (Vuorinen & Martinsuo 2019) and transition rituals and strategic practices (van den Ende & van Marrewijk 2014) differ across project phases (Brandon & Guimaraes 2016).

In the project management literature, the early phase, which is often called the pre-project phase (e.g., Hill, Russell & Smith 1988) or the front-end project phase (e.g., Edkins et al. 2013), typically refers to ideation, negotiation, establishment of a consortium agreement, determining project structure and planning resources, timelines and activities (e.g., Besner & Hobbs 2006) prior to the implementation phase (Labuschagne & Brent 2005). The pre-project phase has been recognised as crucial for outcomes, for value creation (Edkins et al. 2013) and for the overall fate of a given project (Jalali Sohi, Bosch-Rekveldt & Hertogh 2019); therefore, particular attention needs to be paid to its management (Kolltveit & Grønhaug 2004). The presence of multiple stakeholders implies the need for the alignment of conflicting or at least diverging interests, accompanied by the need for the integration, coordination and management of the interactions of all the organisations involved (Karlsson, Larsson & Öhrwall Rönnbäck 2018), makes the pre-project phase riskier, fuzzier and more chaotic than later phases (Floricel, Michela & Piperca 2016).

Even though scholars agree on the criticality of the pre-project phase, its management may differ depending on the industrial sector, organisational context, type of market, innovation and institutional, political and other factors (Edkins et al. 2013; Nobelius & Trygg 2002). Three views on the appropriate management of the pre-project have been the focus of discussions in the literature. The flexible project management style involves proactive managerial responses and continuous adjustments to accommodate environmental dynamics (Jalali Sohi, Bosch-Rekveldt & Hertogh 2019; Nguyen et al. 2018; Nobelius & Trygg 2002) because formal rules and process management may undermine creativity in this phase and may be more valuable in the project implementation phase (Poskela & Martinsuo 2009). The second is a formal and conventionally ‘hard’ project management style (Larsson, Eriksson & Pesämaa 2018), and the third is a combination of a certain level of flexibility and some degree of control (Kock, Heising & Gemünden 2016; Koppenjan et al. 2011).

The *Project Management Body of Knowledge Guide* (*PMBOK Guide*; Project Management Institute 2013), states the 'kick-off' meeting for the beginning of the project implementation phase. This relatively structured phase (Christiansen & Varnes 2009) can bear a lower level of uncertainty than the pre-project phase (Ettlie & Elsenbach 2007). Resistance to change is one of the main challenges that participating organisations may face during the implementation phase (Farr, Sin & Tesluk 2003), so innovation-supportive organisational cultures, supervision and leadership styles (Axtell et al. 2000; Hammond et al. 2011), along with formal process management and control (Christiansen & Varnes 2009), are advocated as appropriate management styles.

To provide a more comprehensive understanding of the establishment and management of coopetitive R&D projects, this dissertation explores the specifics of both the pre-project and project implementation phases.

3 Research Design

Chapter 3 presents the research design of this dissertation in the following manner: first, the research paradigm is presented, followed by the methodological choices. The final section elaborates on the quality of the research.

3.1 Research paradigm

A research approach depicts the plans and procedures used to study a specific topic or phenomenon. The approach evolves through the intersection of the researcher's broad philosophical assumptions, the research design and the methods chosen for data collection and analysis (Creswell & Creswell 2018). Philosophical assumptions refer to a given researcher's ontological and epistemological beliefs, which determine his or her view of reality and further influence the choice of research design and methodology (Guba & Lincoln 1994).

Ontology questions the fundamental forms of being and the very nature of reality, which may be seen a single 'objective' reality which is truly given, as for instance in natural sciences, or a 'dynamic' or 'multiple' reality that depends on complex social interactions (Ladyman 2007). Epistemology is the theory of knowledge that outlines what is considered as knowledge and known (Stone, 2008) and what is the relation between the researcher and the 'known' (Denzin & Lincoln 2005, p. 22). Furthermore, it refers to rationality, the meaning of truth and the justification of knowledge (Stone 2008). Lastly, methodology is the way researchers act to obtain knowledge of the world or reality (Denzin & Lincoln 2005). Methodology refers to particular methods of data collection, analysis and interpretation (Creswell & Creswell 2018, p. 53).

Ontological, epistemological and methodological beliefs together comprise a paradigm that guides the researcher's actions (Denzin & Lincoln 2005). At a very general level, some of the major interpretative paradigms are positivist, postpositivist, constructivist, critical and feminist (Denzin & Lincoln 2005).

The positivist paradigm emphasises the objective nature of reality and observation and measurement as ways to gain knowledge of reality (Fox 2008). Positivism does not fully acknowledge the role of human reasoning, understanding and interpretation. Furthermore, without acknowledgement of the context, it tries to come to a universal truth that can be generally applicable. By contrast,

constructivism situates the researcher as an actor rather than a neutral observer and reactor; therefore, the researcher creates and co-creates new knowledge (Mir & Watson 2000). Following the constructivist paradigm, the researcher's philosophical position guides the construction of the problem, decisions on the appropriate research design and choice of procedures and methods; then, in interaction with the phenomena, that position co-creates knowledge.

The beliefs of the author of this dissertation are not aligned with either positivism or constructivism as two polar opposites; the closest position to my beliefs is the postpositivist paradigm. Historically, postpositivism emerged after positivism as a criticism of and way to address positivism's shortcomings. The main premise that differentiates postpositivism from positivism is the acknowledgement of multiple realities that can be explained by interpretative methodologies (Denzin & Lincoln 2005). In contrast to positivist claims about a single objective reality and one absolute truth, postpositivism acknowledges the role of context and contingencies and aims first to understand and only then to explain. Researchers are aware of their imperfect reflections and interpretations of the world. They strive for detachment while accepting that it is not absolutely possible and leads only to an approximate truth (Fox 2008). The postpositivist paradigm acknowledges the actors or objects of study as active subjects and highlights the need for researchers to understand subjects' ways of thinking in order to interpret them. In line with postpositivism, this dissertation aims to understand and then explain coopetitive relationships in the specific context of mature manufacturing industries. Furthermore, by focusing on relationships, this dissertation acknowledges the active nature of the objects of the study.

This dissertation further resonates with critical realism as one perspective within postpositivism (Fox 2008). This ontological position recognises several layers of reality: real, actual and empirical (Bhaskar 1978). While real and actual realities exist and function without our awareness, the empirical layer is the only layer of reality that we can observe and explore. That acknowledges the existence of an independent reality, while our imperfect and relatively subjective interpretations of its empirical layer prevent an absolutely true interpretation of it. Therefore, obtaining knowledge requires a certain rigour, use of multiple data sources, theory building and theory testing.

Critical realism also emphasises the importance of context for understanding a phenomenon (Miles & Huberman 1994) and aims to uncover the underlying

processes and causalities that are not general but rather inherent in a certain context and thus may not happen regularly (Maxwell 2004). Bearing in mind our ability to analyse only one layer of reality – the empirical layer – embedded in the context of mature manufacturing industries, this dissertation does not aim for absolute truth or rigid generalisations that can be readily applied to other contexts. In line with the critical realist standpoint, that is acknowledged as a clear limitation in all the empirical studies that are included in this thesis.

3.2 Methodology

Methodology represents the particular ways that researchers use to obtain knowledge of the world or reality. It involves data collection, analysis and interpretation. A qualitative method is appropriate when the aim is to understand a complex and dynamic phenomenon and build or extend theory (Eisenhardt & Graebner 2007). The case study research methodology is typically used to develop theory based on empirical data about an emerging phenomenon or a phenomenon that remains poorly understood (Eisenhardt & Graebner 2007). Unlike, for example, experiments that explore phenomena in isolation, case studies enable the investigation of a phenomenon in its real-world setting (Yin 2003), based on multiple data collection methods and/or multiple sources of evidence (Eisenhardt 1989). While single case studies provide rich descriptions of a phenomenon based on a particular case, multiple case studies enable within- and cross-case analysis to identify differences and similarities between cases (Eisenhardt & Graebner 2007). The qualitative case study approach is typically used for inductive and abductive theory building.

Even though case study research may be criticised as potentially subjective, Eisenhardt and Graebner (2007) indicate that a close connection between the researcher and the data keeps researchers honest. My belief is that objectivity during data collection like interviews is attained through limited interference by the interviewer with the interviewee. This is certainly rooted in the critical realist research paradigm, since I do not consider myself a co-creator of reality or knowledge; rather, I am as objective as I can be in observing only the empirical layer of reality.

Case studies are a common method for studying business networks and coopetition strategies where the real-life context is important for understanding the

phenomena of interest (Tidström & Rajala 2016). While we cannot claim a lack of existing theory on coopetition, scholars have indicated that research on coopetition for innovation remains in its infancy (Bouncken et al. 2015) due to the large volume of conflicting and contradictory findings in quantitative studies. Therefore, there is ample room for extending existing theory and enhancing our understanding of this paradoxical, complex phenomenon by undertaking more in-depth qualitative research.

This dissertation employs a single case study research design, of which there are two main types: holistic and embedded. The multiple case study replication logic (Eisenhardt 1989), where the initial framework depicts what can be found under which conditions, can reveal similar or contrasting results within cases, is not suitable since answering the research questions posed in this dissertation required comprehensive insights into a particular case. As indicated by Yin (2009), the choice of a single case study is justified when 'the case represents (a) a critical test of existing theory, (b) a rare or unique circumstance, or (c) a representative or typical case, or where the case serves a (d) revelatory or (e) longitudinal purpose' (p. 52). Unlike a holistic single case study, where subunits cannot or do not need to be identified since doing so would not add to our understanding, an embedded case study involves more than one subunit of analysis (Scholz & Tietje 2002). This dissertation is an embedded case study of mature manufacturing industry with the subunits being individual coopetitive R&D projects. Mature manufacturing industries as a case is a unique context that has not been deeply explored in either the OI or the coopetition literature, which helped guide my methodological choices.

One disadvantage of the holistic single case study is its more abstract examination; by comparison, an embedded case study design offers the flexibility to follow and adjust to potential changes in the nature of the case during the research, changes that may even require adjustments to the research questions (Yin 2009). However, to ensure the benefits of an embedded case study approach, it is important to maintain a focus on both subunits and the larger case, which means that the holistic aspects of a case cannot be completely ignored during the research process (Scholz & Tietje 2002; Yin 2009). The findings of this dissertation have been constantly evaluated in regard to a specific context of mature manufacturers, and I have made every effort to avoid this pitfall and mitigate any effects that may have resulted from it.

3.2.1 Sampling strategy

Six case projects were purposively sampled at the beginning of this project with the aim of theory development in all empirical publications. The main selection criteria were that a project:

- Involved two or more competing companies from mature manufacturing industries and
- Aimed for R&D and innovation.

Five of the projects were identified within one business cluster whose members are world-leading competing companies delivering equipment to the mature oil and maritime industries. This business cluster was chosen as a starting point since it and its member companies have a strong strategic focus on innovation and collaboration. In line with the selection criteria, the projects were identified through information provided by cluster managers and a careful examination of publicly available information about the projects, such as project and company webpages and media articles. During the data collection process, the researcher obtained information from informants about one additional coopetitive innovation project in a mature industry outside the cluster. After careful examination of publicly available information, this project also proved relevant and was therefore included as a case project. The final sample consists of six projects. The characteristics of the sampled projects are presented in Table 5.

Table 5: The sample

Project	Participants	Description and Status	Funding	Type of informants	Informants per project
1	Four competing companies, one university, one research institute and a business cluster. The companies participating in the project had different sizes and the owners of the companies came from different countries.	The project aimed to develop a new technology in the fields of hydraulics, robotics and automation. At the time of the investigation, the project had reached its mid-term evaluation. The R&D activities were carried out in several work packages, with competitors involved together in most of them.	The project was funded by the companies and the Research Council of Norway.	PM, HLM, MLM, CM, RIe, Ue	16
2	Four competing companies, a few other non-competing companies, one business cluster and one university. The participating companies had different ownership and sizes.	The project aimed to develop and implement a new test laboratory for testing new technologies. It was already finalised in the time of investigation.	The establishment of the laboratory was funded by the university, but the laboratory needs to work according to market principles and be self-sufficient.	PM, HLM, MLM, CM, RIe	7
3	Two competing companies and several other companies and universities.	The project aimed to develop a new model for data sharing to unlock the value of data in the manufacturing sector. The competing companies were separated into two different	The project was funded by the companies and Business Finland.	PM, HLM, MLM	3

	The participating companies were nationally owned and had similar sizes.	work packages. The project implementation phase has just begun at the time of the investigation.			
4	Two competing companies, two non-competing companies, one university and one research institute. The competing companies had different sizes and ownership.	The project aimed to develop new business model. The project was in the pre-project phase at the time of the first round of date collection and, due to tensions, one competitor left the project just before our investigation. Later, another competing company joined the project and follow-up interviews were conducted to enable analysis of the project implementation phase.	The project was funded by the companies and the Research Council of Norway.	PM, HLM, CM, Ue, RIe	6
5	Two competing companies, three non-competing companies, one university, one research institute and one business cluster. Both competing companies were large, but there was a difference in their country of ownership.	The project aimed to develop a new business model and new services. One of the competing companies decided to leave the project during the pre-project phase, just before our investigation began.	The project was funded by the companies and the Research Council of Norway.	PM, HLM, MLM, CM, RIe	8

6	One university, one business cluster, four competing companies and several non-competing companies.	The project aimed to develop an analysis model in line with new environmental regulations. The project was in the implementation phase at the time of our investigation.	The project was funded by Innovation Norway and the companies.	CM Ue MLM HLM	4

Source: Retrieved from Papers 1, 2 and 3. Legend: PM, Project manager; HLM, High-level manager (CEO, vice president); MLM, Mid-level manager; CM, Cluster manager; RIe, Research institute employee; Ue, University employee.

All sampled projects were not equally relevant for addressing the specific research questions in the three papers. All projects were relevant for addressing RQ1, related to establishment. One project was not relevant for addressing RQ2, related to tensions, due to the fact that a number of key informants had left the participating companies and therefore no longer had any authority to discuss the highly sensitive topic of tensions. One project was not relevant for exploring the role of non-competitive partners since there only a limited number of key informants from non-competitive partners available for interviews. Detailed information about the specific projects explored to address specific questions is presented in Table 6.

Table 6: Overview of projects addressing particular RQs

RQ or identified problem	Sample
1) How do competing companies evaluate opportunities to engage in coopetitive R&D and innovation projects in mature industries?	Projects 1, 2, 3, 4, 5 and 6
2) How are the tensions in different project phases of coopetitive R&D and innovation projects in mature industries managed?	Projects 1, 2, 3, 4 and 5
3) How do non-competitive partners influence coopetitive collaborations in different project phases of R&D and innovation projects in mature industries?	Projects 1, 2, 4, 5 and 6

3.2.2 Data collection

Prior to data collection, the specific requirements of both universities were addressed. In line with the requirements of The University of Agder in Norway, a notification was filed to The Norwegian Centre for Research Data. Following ethical evaluation and the governance requirements of RMIT University, an ethics application was filed and approved for all empirical studies (please see Ethics approval in Appendix A).

Data collection for the three empirical publications began in winter 2018 and ended in spring 2020. The sampled projects had reached different phases at the beginning of the investigation. One project was in the pre-project phase, four in the implementation phase, and one had already been finalised. To capture the

implementation phase of the project that had just begun, data for this project were collected in two rounds. In addition, follow-up interviews with some of the informants were conducted to clarify and enrich the findings whenever necessary.

Data were collected through semi-structured in-depth interviews with key informants involved in the case projects. A snowballing procedure was used to identify informants who 1) were directly involved in the projects, 2) possessed rich information and 3) had a mandate to discuss this sensitive topic. The cluster managers provided information about project managers. Therefore, the first informant was the project manager of each project, who suggested other informants from different organisations involved in the same project. This procedure has proven valuable for reaching informants because their willingness to participate is based on trust (Atkinson & Flint 2004), and trust was particularly important in the present study due to the sensitive nature of coopetition. Furthermore, snowballing is suitable when informants belong to elite groups (Atkinson & Flint 2004); in our case, this refers to managers involved in the selected projects. This approach may also have some disadvantages such as omitting some informants who were not connected with the specific groups or considering only positive aspects because interviews with project managers served as starting points. Those disadvantages were mitigated in the following ways: the interviews were conducted until information saturation for a particular project was reached. Furthermore, the issues between competitors in some projects were already in place; for instance, some competing companies had already left a project, so I was able to hear both sides of the story.

The interviews were conducted with decision-makers from mid- and high-level management, project managers, cluster managers and researchers from research institutions involved in the project. Different views from diverse individuals involved in the projects allowed me to compare and contrast findings, thus enriching the data. The total number of informants was 30; the specific numbers of informants in each sampled project is presented in Table 5. Some informants participated in several projects and were therefore interviewed about more than one project. The total number of interviews, including follow-up and second-round interviews, was 48. All interview details are available in the three empirical papers.

The interviews lasted between 60 and 90 minutes. An interview guide was developed and consisted of open-ended questions combined with follow-up questions (see Appendix B). The guide was adapted to the perspectives of different

informants (research partners, project managers and cluster managers). All interviews were audio-recorded and transcribed verbatim. The transcriptions were carried out in line with established and approved ethical procedures. Additionally, the researcher took notes during the interviews and used multiple sources of information, such as information from webpages about the projects and participating companies and press releases and presentations provided during the interviews, to prepare for the interviews and better understand and contextualise the collected data.

3.2.3 Data analysis

A combination of inductive (Papers 1 and 3) and abductive (Paper 2) approaches was chosen as most suitable for data analysis, based on the following criteria:

- The qualitative nature of the research, the aim of which is to enhance our understanding due to the divergent findings reported in quantitative studies.
- The researcher's main aim of extending existing theory. Therefore, the existing theory is acknowledged in each of the papers. However, the findings emerged from the data, without the restrictions imposed by, for instance, a deductive approach in which the researcher tests whether the data comply with already established theories or hypotheses. Flexible pattern matching was used in Paper 2 to guide and better showcase new insights that may extend current knowledge.
- Both inductive and abductive analysis are often used by other researchers adopting the critical realist paradigm (e.g., Miles & Huberman 1994; Miles, Huberman & Saldaña 2014).

Induction is a systematic process of qualitative data analysis that can lead to reliable and valid findings (Thomas 2006) or, as Ladyman (2007) explains, provide the explanation that best justifies beliefs and knowledge. Theory development using inductive analysis starts with a brief summary of the raw data, establishing connections between the findings and the researcher's aims and objectives, ensuring transparency and justification and developing a framework or model that outlines the structure or processes that emerged (Thomas 2006).

Although it is widely used in qualitative research, the inductive approach has also been subject to strong criticism. One of the main issues is based on the argument that it is not possible to draw conclusions about unobserved elements

based on the small part of reality that we observe (Ladyman 2007). Roy Bashkar, who is considered a founder of critical realism, has addressed these criticisms in several ways. He reframes the challenge described above as doubt over whether the unobserved will behave in the same way as what is observed, which should not be a concern if we were able to, first, correctly observe and, second, accurately describe what was observed (Bhaskar 2008, p. 197). According to him, induction is used to discover the nature of things and things of a certain nature will tend to behave in the same manner. Otherwise, they would not have the same nature: 'It is the real stratification of nature that justifies induction in science' (Bhaskar 2008, p. 205). Therefore, if we are able to understand the nature of a thing and identify the system in which it belongs, induction is justified.

Abductive analysis has been applied in Paper 2 because research on tensions in general has been quite comprehensive, and the maturity of the literature has enabled me to derive broad assumptions to guide the analysis. Therefore, the contribution to research on tensions in relation to coopetitive project phases could be better facilitated by using an abductive approach. According to Peirce (1960) abduction, when regarded as the examination of knowledge that has been found before us, is the first step in any scientific research process. However, the main difference between abduction and induction is that abduction uses both theoretical and empirical facts and searches for exploratory patterns, thus becoming a problem-solving strategy (Åsvoll 2013).

Abductive reasoning has been acknowledged as very valuable for developing new explanations in the management field based on a constant alternation between empirical insights and background knowledge or theoretical explanations (Birkinshaw et al. 2014). Abduction offers the opportunity to undertake contrastive analysis, which means going beyond a sole explanation to reinterpret the nature of the phenomena or the assumptions made several times based on previous research without being afraid to correct initial assumptions and reveal new, unexpected insights (Folger & Stein 2017). Birkinshaw et al. (2014) further argue that, since empirical observations may challenge our existing understanding, abduction is particularly important for the development of more firmly grounded management theories. Abduction is also a means to arrive at more open and alternative theoretical explanations and frameworks (Patokorpi & Ahvenainen 2009).

In line with Peirce's (1960) understanding, the analysis applied in all the papers in this dissertation may be considered abductive, since previous research is always

acknowledged. However, my view is that Paper 2 fully accommodates abduction because it challenges theoretical assumptions based on empirical observations, whereas the other two papers are of a more exploratory nature, and data collection and analysis were conducted without constant comparison and alternation with theoretical knowledge and assumptions. The aim of Paper 2 has been achieved by using an abductive, flexible pattern-matching approach that combines inductive and deductive logics and has been increasingly used for theory building and extending established theoretical boundaries (Sinkovics et al. 2019). Flexible pattern matching implies iterative matching between theoretical patterns and empirical observations; any mismatches that are revealed lead to the refinement of the initial theoretical assumptions, which is its main distinction from using pattern matching to test a theory (Bouncken & Barwinski 2021; Bouncken et al. 2021; Sinkovics et al. 2014). Following this approach, interview data were first descriptively summarised and grouped according to classifications that had already been established by previous research. An example of the coding process from Paper 2 is presented in Appendix C. Thereafter, an iterative comparison between the initial theoretical assumptions and empirical observations was undertaken, with particular attention paid to mismatches and the consequent refinement of those assumptions to account for the empirical observations.

The data analysis process consisted of coding and within-embedded case study analysis. Coding was performed following a two-cycle coding logic in accordance with the recommendations of Miles, Huberman and Saldaña (2014). The NVivo 12 software package was used to support the coding process. In the first cycle of coding, segments of data were descriptively summarised. During this process, new insights were noted as they emerged from the data. In the second coding cycle, patterns were identified, based on which previously identified codes were grouped into explanatory categories. This allowed the researcher to identify emerging themes and explanations. An iterative process of creating and revising codes continued until a sufficient level of understanding of the data was reached. As soon as the coding was completed, a within-case analysis was performed in an effort to understand, describe and explain what happened. During the analysis, the secondary data were used to deepen the understanding of the context, focus and progress of the sampled projects. For instance, internal project documentation describing organisational structures, annual progress reports, documentation regarding the pre-project phase, project-related presentations from individual

companies, press releases and publicly available data from companies' and projects' webpages were all used. This information helped better understand the information obtained during the interviews.

3.3 Quality of research

Assessing the quality of research means applying certain widely accepted systems of quality criteria in line with the research paradigm and the quantitative or qualitative nature of the research. Due to the postpositivist research paradigm adopted in this dissertation, the quality of research is assessed based on the following trustworthiness criteria, which are appropriate for the exclusively qualitative nature of the study (Guba & Lincoln 2005): credibility, transferability, dependability and confirmability. Those criteria were introduced by Lincoln and Guba (1982), who proposed that 'internal validity should be replaced by that of credibility, external validity by transferability, reliability by dependability and objectivity by confirmability' (pp. 3–4).

The credibility of qualitative research corresponds to internal reliability in quantitative research and indicates whether the findings reflect the reality of explored phenomenon (Shenton 2004). The credibility of the research incorporated into this dissertation has been ensured in a variety of ways. All explored projects included multiple partners. Interviewing informants with differing perspectives – employees of competing companies, research partners, cluster managers and project managers – enriched the credibility of the findings. Triangulation of the interview data with internal project documentation and publicly available information was used to better understand the data during a data analysis process that was performed in collaboration with co-authors. Furthermore, the findings were presented and widely discussed at a workshop in which both practitioners and informants involved in the research were present.

The transferability of qualitative research corresponds to external validity or generalisability in positivist research (Shenton 2004) and represents the applicability of the findings to other contexts (Rohleder & Lyons 2014). Qualitative research typically relies on a limited amount of data compared to the large data sets that form the basis for most quantitative studies, and therefore it is typically not possible to ensure transferability of the findings to other contexts and populations (Shenton 2004). Guided by the critical realist research paradigm, the

present study acknowledges the importance of context and – rather than general transferability to all other contexts – the main aim was to provide thick, context-specific information (Guba 1981, p. 86), details about the informants, sampling and the obtained data so readers can evaluate whether the findings apply to the same type of context, the mature manufacturing industries, beyond the particular industries analysed in the dissertation. In other words, rich descriptions were used to ensure the transferability of the findings across the same type of context.

The dependability of qualitative research corresponds to reliability in positivist research and represents the extent to which a repetition of the same research in the same context and with the same data would lead to the same findings (Shenton 2004). Triangulation of information and discussions with co-authors and other researchers were used to ensure dependability, coupled with a detailed description of the research design and data collection process. Furthermore, all interview data were recorded, transcribed and stored.

The confirmability of qualitative research corresponds to objectivity in positivist research and represents the objectivity of the findings; in other words, they should reflect the opinions and experiences of the informants rather than the opinions and experiences of the researcher (Shenton 2004). The confirmability of the research incorporated into this dissertation has been ensured through triangulation. Denzin (1978) describes four main types of triangulation: data, methods, investigator and theory triangulation. Data and investigator triangulation have been applied in this dissertation. The triangulation of sources was carried out through interviews with multiple informants who had varying perspectives. These were not only individuals from competing companies but also project and cluster managers and research partners involved in the sampled projects. This enabled a comparison of perspectives and more reliable and nuanced interpretations. Analytical triangulation has been achieved by having the data analysis performed by more than one author. Two authors read the transcriptions (Papers 1 and 2) separately and then discussed the data and jointly carried out the analysis. After that, all three authors jointly discussed the findings to consider all alternative interpretations by adopting the devil's advocate role.

Detailed descriptions and explanations of the chosen method and a detailed presentation of the interview data in the form of rich and numerous quotes – together with clearly stated limitations for each paper – should help readers assess the confirmability of the research presented in this thesis. As they are presented in

the papers, the findings strike a balance between quotes to make the knowledge and understanding of the informants visible and interpretations (Morrow 2005). Readers thus have access to raw data and can craft their own interpretations while going back and forth between data and interpretation (Beverland & Lindgreen 2010). The findings are not in summary form, and detailed descriptions of analysis and coding are provided.

Furthermore, the findings of the papers were presented and discussed in several contexts: 1) during meetings with other researchers at both UiA and RMIT University; 2) at several conferences (an early version of Paper 1 was presented at the 2019 *R&D Management* conference, while an early version of Paper 3 was presented at the 2019 *World Open Innovation Conference* and again at *ISPIM* online conference in June 2020); and 3) all three papers were evaluated by rigorous peer-review processes characteristic of highly ranked journals.

4 Papers and overview of the results

The overall aim of this dissertation is to reveal how multi-partner coopetitive R&D and innovation projects in mature industries can be established and managed. The main aim is operationalised into three research questions, which are addressed in the individual papers. Brief summaries of the main aims, findings and contributions of each paper follow.

4.1 Paper 1: Is Joining the Party Worth It? Insights from Coopetitive R&D Projects

Main aim and findings

The main aim of this study was to reveal how competing companies in mature industries evaluate invitations to join coopetitive R&D and innovation projects involving both competitors and non-competitors (RQ1). This perspective distinguishes the paper from previous studies that typically examined the formation of coopetitive and non-coopetitive partnerships separately, mostly from a focal-firm partner selection perspective. The findings suggest a complex two-step evaluation process: first, an assessment of the project characteristics and then an evaluation of the project partners. Both steps are based on a specific set of criteria, and different degrees of compliance may lead to different outcomes.

Theoretical contribution

This paper provides new knowledge about partner selection for collaborative innovation (Geum et al. 2013; Guertler & Lindemann 2016; Kraus et al. 2018), the attractiveness of multi-partner R&D collaborations (Borch & Solesvik 2016; Ritala et al. 2017; Yang et al. 2020; Yang 2020) and multi-partner coopetitive projects (Rouyre & Fernandez 2019; Yang 2020). Furthermore, trust in research partners has been revealed as one way to mitigate coopetitive risks in the context of mature industries (Borch & Solesvik 2016; Jakobsen 2020; Solesvik & Encheva 2010). Therefore, a contribution has been made to the R&D, innovation and coopetition literature. Based on the findings, theoretical propositions are derived to explain how the opportunity to join coopetitive R&D projects has been assessed in the context of mature industries. The propositions featured the importance of

perceived benefit for end customers, project complexity and project scope (outside companies' core competencies) in the project evaluation step and trust in research partners, potential for long-term collaboration and collaboration with competitors of similar size in the partner evaluation step.

Managerial implications

The establishment of coopetitive R&D projects in mature industries may not always be a smooth and straightforward process for all potential partners. The identified evaluation model and propositions reveal the critical points where the establishment of the project may be suspended by competing companies that are invited to join and illustrate the possible outcomes of each step. Following those steps and the suggested criteria related to each of them might help practitioners to better guide the negotiation process and ensure that it leads towards desired outcomes for all participants.

4.2 Paper 2: Coopetitive tensions across project phases: A paradox perspective

Main aim and findings

The main aim of this study was to qualitatively explore and explain the nature of the tensions and their management across different project phases: in the pre-project phase, when coopetitive innovation projects are initiated and planned, and in the project implementation phase, when coopetitive innovation projects in mature industries are executed (RQ2). The findings indicated that tensions and their management differ across the different phases of coopetitive innovation projects in mature industries. Strong intra-organisational tensions may appear during the pre-project phase because of performing and organising paradoxes, and learning paradoxes may trigger inter-organisational tensions during this phase. The management of intra-organisational tensions is based on a working-through strategy (Smith & Lewis 2011) at the firm level. In the project implementation phase, performing, organising and learning paradoxes trigger inter-organisational tensions. Managing inter-organisational tensions calls for a mix of working-through and splitting-and-iteration (Smith & Lewis 2011) strategies at both the project and firm levels.

Theoretical contribution

The appropriate management of tensions has been described as critical for the success of coopetitive innovation projects (e.g., Fernandez, Le Roy & Gnyawali 2014). Thus, the insights provided by this paper are highly relevant for coopetition in both theory and practice. This study sheds new light on the coopetition paradox (Bengtsson, Raza-Ullah & Vanyushyn 2016; Fernandez, Le Roy & Chiambaretto 2018; Fernandez, Le Roy & Gnyawali 2014; Gnyawali et al. 2016; Raza-Ullah, Bengtsson & Kock 2014;), revealing how different organisational paradoxes (Smith & Lewis 2011) influence coopetitive tensions and management styles. Discussions about intra- versus inter-organisational tensions (e.g., Bengtsson, Raza-Ullah & Vanyushyn 2016) and coopetitive dynamics (Dahl 2014; Pattinson, Nicholson & Lindgreen 2018) are enriched by the paper's findings about specific project phases when one or the other type of tension is prevalent. Some of the findings, such as strong intra-organisational tensions in the pre-project phase, enhance our understanding of the peculiarities of mature industries (Czakon & Rogalski 2014; Jakobsen 2020). Lastly, in exploring the projects, the study revealed a strong interrelation between the project and company levels. Furthermore, propositions presented in Paper 2 may guide future empirical studies.

Managerial implications

The findings presented in Paper 2 provide knowledge support to project managers, companies and other relevant parties, such as research institutions and business clusters, that aim to join forces with competing companies in innovation projects. There is no unique way to manage an entire project, and the findings suggest that companies in mature industries may expect strong intra-organisational tensions in the pre-project phase. In the project implementation phase, critical attention needs to be paid to inter-organisational tensions that appear at the project level. Our findings also suggest that firms' top-level management is responsible for managing intra-organisational tensions, whereas project managers – either on their own or together with firm managers for certain tensions – are in charge of dealing with inter-organisational tensions.

4.3 Paper 3: Beyond the dyad: Role of non-competitive partners in coopetitive R&D projects

Main aim and findings

While the coopetition literature has largely explored the competitor-to-competitor dyad and considered, to a limited extent, the influence of non-competitive partners, the main aim of Paper 3 was to explore the role and influence of research partners and clusters on relationships between competing companies in the pre-project and project implementation phases of coopetitive R&D projects in mature industries (RQ3). The findings revealed that research partners and clusters need to be simultaneously involved for the establishment of collaboration in the pre-project phase. Furthermore, the findings indicated that research partners balance coopetition and enable cooperation in both project phases, while clusters' only role is enabling cooperation during the both pre- project and project implementation phases; clusters have no influence on the coopetitive side of these relationships. Details on the findings for each phase are presented in Tables 7 and 8, which are adapted from Smiljic (2020).

Table 7: Research partner and cluster roles in the pre-project phase (Smiljic 2020)

Role/Partner	**Research partners**	**Clusters**
Establishing cooperation		Platform mechanism to accelerate innovation
	Idea generation	
	Research capabilities as a selling point offered to the companies	
	Writing the application	Lobbying for the project at government level
	Leading the project: consortium agreement, organising the structure, defining the scope of work and establishing the rules	Leading the project: administrative lead, organising the structure in some cases
Balancing coopetition	A neutral partner between competing companies: Establishing data sharing vs. data protection mechanisms	No role

Table 8: Research partner and cluster roles in the project implementation phase (Smiljic 2020)

Role/Partner	Research partners	Clusters
Enabling cooperation	Participation in project governance (e.g., position on steering board)	Participation in project governance (e.g., position on steering board)
	Leading the project: full managerial role (decisions about organisational structure, contributions, rules, tensions)	Leading the project: administrative managerial role
Knowledge creation and dissemination	Enabling technology	Communication with companies to identify potential spin-offs
	Creating scientific knowledge	Results dissemination
	Creating problem-solving and practical knowledge	
Balancing coopetition	Neutral partner between competing companies: ensuring information sharing necessary for project continuity	No role
	Actor causing tensions regarding an increased need for information	
	Establishing new modalities for collaboration between competing companies	

Theoretical contribution

This study provides novel theoretical insights into the roles of non-competitive partners for 1) establishing collaborations, 2) implementing collaborations and 3) knowledge flows between competing companies in multi-partner R&D projects in mature industries; it thus adds to the growing number of studies discussing the role of third parties in coopetitive projects (Chou & Zolkiewski 2017; Czakon & Czernek 2016; Fernandez & Pierrot 2016; Rouyre & Fernandez 2019; Tidström, Ritala & Lainema 2018). Another important contribution has been made by revealing how non-competitive partners improve coopetitive collaborations, mitigate the challenges that arise in those contexts and therefore influence

relational success during the pre-project and project implementation phases of multi-partner coopetitive R&D projects (Henttonen, Hurmelinna-Laukkanen & Ritala 2016; Rouyre & Fernandez 2019; Yami & Nemeh 2014). The set of propositions derived can inform future studies in both the OI and coopetition fields by suggesting which and how non-competitive partners increase the likelihood of successfully establishing coopetitive R&D projects in mature industries and ease – or increase – the tensions between competing companies during the project implementation phase.

Managerial implications

Unpacking complex interactions between competing and non-competing partners in multi-partner coopetitive R&D projects is of particular importance for project managers, competing companies, research partners and business clusters. Knowledgeable actions informed by the findings of this study may enhance collaboration, foster knowledge creation, improve management and, consequently, lead to better outcomes for coopetitive R&D projects in mature industries.

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5 The overall contribution of the dissertation

5.1. Theoretical implications

The findings of this dissertation enhance our understanding of coopetitive R&D and innovation projects in the context of mature industries. Overall, by addressing certain identified knowledge gaps, the study makes important contributions to the coopetition for innovation, collaborative or OI and R&D collaboration literature. This discussion of the contributions is organised according to the literature gaps presented in the Introduction: 1) the role of non-competitive partners in coopetitive R&D collaborations, 2) project-level insights with particular attention to different project phases and 3) the context of mature industries.

First, by acknowledging the often neglected presence of both competitive and non-competitive partners in R&D and innovation projects, this dissertation contributes to debates about multi-partner R&D and innovation partnerships and discussion of the roles and influence of non-competitive partners in multi-partner coopetitive projects (Czakon & Czernek 2016; Rouyre & Fernandez 2019; Tidström 2014; Tidström & Rajala 2016). It advances existing knowledge by revealing the benefits for the competitor-to-competitor relationship caused by the presence of multiple kinds of partners (Yang 2020). The presence of heterogeneous partners has proven valuable for increasing the synergies, research productivity and likelihood of radical innovations in R&D collaborations in the manufacturing industries (Becker & Dietz 2004). The findings of this dissertation show that the involvement of research partners and customers can influence the establishment of coopetitive collaborations by mitigating coopetitive risks and enhancing the willingness of competing companies to join coopetitive R&D and innovation projects. Furthermore, the involvement of trustworthy research partners appeared to be critical establishing projects that involve direct competitors (Paper 1). This dissertation also showcases how a variety of non-competitive partners can influence both the competitive and cooperative aspects of the coopetitive relationship (Paper 3). For instance, business clusters enhance the cooperative aspect, while research partners, in addition to enhancing the cooperative aspect, play leading roles in balancing competitive aspects during both the pre-project and project implementation phases. Scholars have also noted greater knowledge sharing and protection, coopetitive, organisational and managerial issues due to

the inherent complexity of multi-partner R&D projects (Barbic, Hidalgo & Cagliano 2016; Du et al. 2020; Henttonen, Hurmelinna-Laukkanen & Ritala 2016; Ritala et al. 2017). This dissertation has shown that major issues typically arose in coopetitive relationships and that non-competitive partners enhance knowledge sharing – which is particularly relevant for OI – and the management of coopetitive relationships (Paper 3). Therefore, according to this dissertation's findings, the benefits of multi-partner coopetitive R&D and innovation projects outweigh their potential drawbacks (Paper 3).

Second, this dissertation contributes to debates about business-to-business R&D and innovation projects, which have attracted increasing research interest in the OI, coopetition and R&D literature (Markovic et al. 2021). The findings reveal how coopetitive R&D and innovation projects can be established and managed by explaining project establishment from the perspective of competing companies invited to join projects (Paper 1) and the types of tensions that arise in coopetitive relationships and how to manage them, with particular attention to two distinct project phases (Papers 2 and Paper 3). An elaboration of the dissertation's contribution to project-level debates follows.

Scholars argue that different types of projects may be of different strategic importance for companies, which can influence their behaviour and choice of partners and project management styles (Bagherzadeh, Markovic & Bogers 2021; Kim, Kim & Lee 2015; Cho & Lee 2019). The findings of this dissertation enrich our knowledge of the establishment of coopetitive R&D and innovation projects by revealing the specific evaluation process undertaken by competing companies invited to join such projects, in contrasts to the individually applied criteria primarily explored in previous studies. Therefore, the findings add to debates about strategic alignment and rigorous selection of coopetitive projects for a firm's project portfolio (Nemeh & Yami 2016; Unger, Kock & Jonas 2012) by uncovering the steps of the evaluation process, the criteria that need to be met simultaneously or individually and critical points and ways to manage them to enhance the willingness of competitors to join projects. Furthermore, the literature considers trust to be critical for forming R&D collaborative partnerships (Solesvik & Encheva 2010), and trust between competing companies was already among the most heavily researched topics in the coopetition research stream (Czakon et al. 2020). However, trust in third parties, to the best of my knowledge, has been mentioned but not extensively discussed in the coopetition literature (Czakon &

Czernek 2016). This dissertation argues for the crucial importance of trust in research partners, as neutral partners, for the willingness of competing companies to accept invitations to join projects with direct competitors.

An important contribution to project-level debates has also been made by highlighting the peculiarities of the pre-project and project implementation phases (Papers 2 and 3). This dissertation has revealed that, instead of one best way to manage an entire project – the typical topic of discussion in the coopetition literature (Fernandez & Chiambaretto 2016; Rouyre & Fernandez 2019) – there are different critical tensions in each project phase that need to be understood and addressed appropriately. These findings help answer why some projects fail and thus make an important contribution to debates about the management of tensions in coopetitive projects, which has been recognised as the main success factor of such projects in the coopetition research stream (e.g., Fernandez & Chiambaretto 2016; Fernandez et al. 2018). Such projects fail because attention to critical types of tensions is not paid in the project phase when they appear or those tensions are not managed in an appropriate way and at an appropriate level. Intra-organisational tensions are the critical types of tensions in the pre-project phase and need to be managed based on a working-through strategy at the company level. Inter-organisational tensions are the dominant type of tensions in the project implementation phase; they need to be managed by a working-through strategy at the company level and a combination of working-through and iteration-and-splitting strategies at the project level. Therefore, another important and novel contribution of the dissertation is highlighting a certain overlap between the project and firm levels. Even though project-level insights are novel and important, focusing only on that level will not ensure the sustainability of or progress in a project. Especially in the pre-project phase, companies and project managers need to pay attention to both project-level and firm-level challenges. Lastly, this dissertation reveals the greater complexity of the pre-project phase, in comparison to the project implementation phase, because of the influence of various competitive and non-competitive factors and partners and multiple tensions and their management, which opens the door for emerging discussions about the relevance of the pre-project phase in this particular type of project (Papers 1, 2 and 3; Bagherzadeh, Markovic & Bogers 2021).

Third, following the critical realist paradigm, this dissertation acknowledges the importance of context and provides new knowledge about the establishment and management of coopetitive R&D and innovation projects in the context of mature manufacturing industries (Papers 1, 2 and 3). Ongoing scholarly debates indicate that, since the benefits of collaborative R&D projects may not always be visible in mature industries, their appeal to companies may be lower; therefore, it is not only a matter of selecting but also of actively attracting partners (e.g., Borch & Solesvik 2016). This dissertation contributes to those discussions by revealing how competing companies evaluate the attractiveness of coopetitive R&D and innovation projects and the critical points in that evaluation (Paper 1). It is also acknowledged that companies in mature industries may face challenges when opening up their R&D and innovation processes and incorporating external knowledge, which may require changes in organisational structures and internal processes (Caiazza 2015; Chiaroni et al. 2010; Ciravegna & Maielli 2011). When it comes to manufacturing companies, resistance to external R&D has been noted as a major factor limiting their co-innovation capacities (Pereira, Leitão & Devezas 2017). However, according to those authors, internal organisation structures and procedures have no influence on external R&D of manufacturing firms. The findings of this dissertation highlight how the context-related challenges noted above become manifest in coopetitive R&D and innovation projects (Papers 2 and 3). A contribution has been made by revealing that *maturity* influences the challenges that companies *in the manufacturing industries* may experience. During the pre-project phase, companies in mature manufacturing industries, faced strong intra-organisational tensions rooted in performing and organising paradoxes and their internal organisational cultures, decision-making processes and procedures. A lack of the skills and internal capabilities needed to solve those tensions resulted in the withdrawal of some firm from the projects they had joined. While scholars have found that companies in manufacturing industries may experience certain discrepancies between activities at the individual and firm levels that might affect coopetitive relationships at the inter-organisational level (e.g., Tidström & Rajala 2016), this dissertation has provided clear evidence of how those discrepancies may become manifest in the form of tensions and can either be resolved or endanger relationships at the inter-organisational level.

The findings of this dissertation may also be viewed as a contribution to the paradox and dynamic capabilities theoretical perspectives. The contribution to the

paradox literature arises from the in-depth insights into how organisational paradoxes, which are typically explored at the organisational level (Smith & Lewis 2011), may underlie coopetitive paradoxes and emerge in specific types of tensions at the inter- and intra-organisational levels. Furthermore, Smith and Lewis's (2011) paradox management styles have been identified, either individually or in specific combinations, as suitable for the management of those tensions at both levels. Previous research has mainly discussed structural and organisational approaches such as integration, separation or co-management principles (Fernandez & Chiambaretto 2016; Fernandez, Le Roy & Gnyawali 2014; Le Roy & Czakon 2016) and suggested their applicability at different levels (Le Roy & Fernandez 2015), but it has not focused on specific project phases, which is the approach taken in this dissertation.

Lastly, while dynamic capabilities theory has largely elaborated on dynamic capabilities within organisations, it has also witnessed several recent discussions on the opportunity for the co-creation of dynamic capabilities at the inter-organisational level (Bez & Chesbrough 2020; Giudici, Reinmoeller & Ravasi 2018; Teece 2012). Some findings in this dissertation reveal opportunities for co-creating dynamic capabilities through coopetitive R&D and innovation projects. For instance, non-competitive partners may influence the sensing activities (Teece 2007) of competing companies. Specifically, the involvement of clusters may support the identification of opportunities, while the participation of research partners may be of crucial importance for a positive assessment of the opportunities and willingness of companies to engage in the co-creation of dynamic capabilities within such projects (Paper 1). Seizing activities – the mobilisation of resources at the project level – are dependent on the appropriate management of particular types of the tensions between competitors during the project implementation phase (Paper 2). Furthermore, both individual companies and project managers or project management teams are responsible for seizing activities in coopetitive R&D and innovation projects. Finally, the involvement of non-competitive partners, such as those from research partners, may positively influence the mobilisation of resources between competing companies (Paper 3).

From the methodological viewpoint, there are benefits of the qualitative research design used in this dissertation. The large of volume of conflicting findings in quantitative studies about the effects of coopetition on innovation indicate that the quantitative approach has not yet demonstrated that it is the most

effective and thorough method for understanding and explaining the nature and effects of paradoxical phenomena such as coopetition. Contradictory findings can be understood as a demand for qualitative insights that require diving more deeply. The embedded case study design applied in this dissertation provided valuable in-depth insights into the specific context of mature manufacturing industries through a comprehensive investigation of the establishment, management and role of non-competitive partners in coopetitive R&D and innovation projects.

5.2 Practical implications

This dissertation aims to provide knowledge support to project managers, companies and other relevant parties, such as research institutions and business clusters, that aim to join forces of competing companies in R&D and innovation projects. Numerous propositions derived from the empirical papers may serve as tentative guidance for practitioners and help them achieve greater benefits from this type of collaboration.

Due to intense technological pressures, shorter product lifecycles and rising R&D costs, companies in the mature manufacturing industries are increasingly engaging in coopetitive R&D and innovation projects (Cho & Lee 2019; Ritala & Sainio 2014). However, the findings revealed very complex relationships between various partners involved in those projects and many difficulties in managing those relationships and their challenges. Very often, such projects do not succeed, or companies withdraw from collaborations, regarding the time and resources invested as wasted. Therefore, there are important takeaways from this dissertation, presented below, about the types and sources of challenges that can be expected in the pre-project and project implementation phases, about how to manage them and about the roles of different partners, which may help project managers, competing companies and other partners to establish projects, ensure their continuity and reach desirable outcomes.

First, the involvement of business clusters, trustworthy research partners and customers may all significantly enhance the establishment of coopetitive R&D and innovation projects in mature manufacturing industries. Second, in the pre-project phase, a company's innovation strategy (which can vary from more closed to more open) and organisational culture may cause different degrees of intra-organisational tensions. To solve these tensions, company managers must accept

the need for change and apply a working-through strategy that involves adjusting internal procedures and practices. Third, research partners, as neutral partners in the pre-project phase, may help balance coopetition between competing companies by establishing appropriate data sharing and protection mechanisms. Fourth, in the project implementation phase, learning, organising and performing paradoxes cause inter-organisational tensions between competing companies. To solve these tensions, project managers should apply a combination of a working-through strategy and an iteration of separation and integration strategies. In the project implementation phase, attention also needs to be paid to learning tensions at the company level. Fifth, research partners may help balance coopetition and enhance knowledge sharing between competing companies, while business clusters may assist with the dissemination of the results.

Lastly, from a broader policy perspective, the findings in this dissertation imply that when establishing framework conditions for coopetitive R&D and innovation projects in mature manufacturing industries, it is nothing less than crucial to acknowledge the presence of all partners – not just competitors – and properly understand their influence on coopetitive relationships.

5.3 Limitations and future research directions

There is no research without limitations. This dissertation is an exploratory study with a qualitative research design, and the findings are based on a limited number of projects. The focus was exclusively on the mature manufacturing industries which unsurprisingly limits the transferability of the findings to other contexts. Most of the sampled projects had not reached finalisation phase, which prevented a thorough analysis of the complete project lifecycle. In addition, even though all sampled projects involved either suppliers or customers, interviews were conducted only with research partners and business clusters, so the perspective of other non-competitive partners remained underexplored. Furthermore, the policy perspective and interactions between research institutions, industry and government were out of the scope of this research.

These limitations provide numerous avenues for future research. Coopetition is a deeply complex phenomenon, and even in-depth qualitative investigation, typically based on a limited number of interviews, may not be sufficient to form a complete understanding of it. From a methodological standpoint, a mixed methods

approach may help mitigate or even eliminate certain limitations. For instance, it may enhance research breadth by extending empirical evidence and including a much larger number of projects to test the findings and propositions derived from the different papers in this dissertation. A mixed methods study would also enable answering both exploratory and confirmatory research questions. Future studies may therefore perform adopt inductive and deductive approaches within a single study and combine theory development and theory testing (Jogulu & Pansiri 2011). Other suggestions are to use a qualitative method to clarify or complement quantitative findings, to use a qualitative method to better inform quantitative sampling, measurement and analysis and to challenge the questions and results from one method by applying the other (Molina-Azorín 2007).

Future studies may also examine projects that have undergone all phases of the lifecycle: pre-project, implementation and finalisation. Most sampled projects were at least partly funded by the government, so an interesting perspective for future research could be to explore whether and how government funding influences the dynamics in coopetitive innovation projects. While the present study has largely explored the perspective of competing companies, it could be revealing to examine the perspective of all non-competitive partners. Furthermore, comparative studies involving both mature and emergent industries would provide more comprehensive insights about similarities and differences.

A future research agenda can be built by drawing on the findings of this dissertation. For instance, the findings about the types of tensions and their management indicated that activities at the company level do affect project-level activities and vice versa, and longitudinal research could examine this relationship in greater depth. Rather than using the paradox theory lens, factors that underly tensions and their management could be explored based on the contingency perspective or transaction cost theory. The establishment of the projects and evaluation of their attractiveness could be examined from a dynamic capabilities theoretical perspective, while a learning theory or knowledge perspective might be employed to study the role of non-competitive partners in coopetitive R&D and innovation projects. It would also be worth examining and comparing the outcomes of coopetitive multi-partner R&D and innovation projects involving mature manufacturing industries with the outcomes of multi-partner R&D and innovation projects that do not include competitive partners. Similarly, the challenges revealed in this dissertation indicate that opening up the R&D processes

in the context of mature industries may require further research attention. In a similar vein, a new perspective on trust in coopetitive relationships, where trust in non-competitive partners (such as research partners) mitigates distrust in competitive partners, is a promising avenue for future research.

Lastly, future research suggestions can be developed based on practical needs and trends. For instance, research-industry collaboration is a priority on many contemporary policy agendas (Alexander et al. 2020). The policy perspective was beyond the scope of this dissertation, and future studies could explore the influence that policy makers have on the relationships between competitive and non-competitive partners; they could also examine which types of policies and strategies can stimulate R&D and innovation collaborations in the mature manufacturing industries. Next, mature manufacturing industries are also affected by the ongoing fourth industrial revolution, which is characterised by automation and digitalisation (Xu, Xu & Li 2018). Therefore, it can be expected that more coopetitive R&D and innovation projects will either employ or aim to develop digital technologies, and it would be beneficial to obtain more insights into that area, both in the context of mature manufacturing industries and more broadly. In line with all the above suggestions, an interesting question would be how regional and national innovation systems, along with innovation policies, can stimulate the use of digital technology in coopetitive R&D and innovation projects.

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Appendices

Appendix A: Ethics approval

RMIT UNIVERSITY

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Notice of Approval

Date:	17 December 2018
Project number:	21858
Project title:	*Open innovation practices between competitors i.e. coopetition within industries*
Risk classification:	Low Risk
Chief Investigator:	Prof Anne-Laure Mention
Research Student:	Sanja Smiljic
Other Investigators:	Prof Tor Helge Aas

Project Approved: **From: 17 December 2018** **To: 17 December 2021**

Terms of approval:

Responsibilities of the principal investigator

It is the responsibility of the principal investigator to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by BCHEAN. Approval is only valid while the investigator holds a position at RMIT University.

1. *Amendments*
   Approval must be sought from BCHEAN to amend any aspect of a project including approved documents. To apply for an amendment submit a request for amendment form to the BCHEAN secretary. This form is available on the Human Research Ethics Committee (HREC) website. Amendments must not be implemented without first gaining approval from BCHEAN.
2. *Adverse events*
   You should notify BCHEAN immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
3. *Participant Information and Consent Form (PICF)*
   The PICF must be distributed to all research participants, where relevant, and the consent form is to be retained and stored by the investigator. The PICF must contain the RMIT University logo and a complaints clause including the above project number.
4. *Annual reports*
   Continued approval of this project is dependent on the submission of an annual report.
5. *Final report*
   A final report must be provided at the conclusion of the project. BCHEAN must be notified if the project is discontinued before the expected date of completion.
6. *Monitoring*
   Projects may be subject to an audit or any other form of monitoring by BCHEAN at any time.
7. *Retention and storage of data*
   The investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Regards,

Dr Christopher Cheong
Chairperson
RMIT BCHEAN

Appendix B: Interview Guide for managers from competing companies (Paper 1)

Introduction		
• Short presentation outlining the purpose of the study		
• Declaration of confidentiality and use of the interview		
• Information about the interviewee (education and work experience)		
Informant	Personal details	
	Background	Can you tell me about yourself: Education, seniority and roles?
	Function in the project	Can you tell me about your position in the company? What is your role with regard to innovation projects and the one in which we are specifically interested?
Dimension		Questions
Innovation strategy and policy of the company		Does your company have a specific innovation strategy? Can you please explain?
		Does your company have a specific organizational unit for R&D, technological collaboration, etc.?
		How open is your company to innovative collaboration with others and with competitors? Answer on a scale from 1 (not open) to 5 (completely open).
		What do you see as the benefits and disadvantages of collaboration with competitors for innovation?

Decision-making process for a specific project	How often does your company participate in this type of R&D project with competitors involved?
	Who was the initiator of the project? Who invited your company to join the project?
	What was the overarching goal of the project?
	Who from your company was involved in negotiations? Who were the other participants in the negotiations?
	What was the mandate of the person from your company?
	What does the decision-making process look like in terms of actors, role, time frame and issues?
Partner selection criteria and process	What was the motive for your company to join this project?
	Does your company have specific requirements in the initiation phase?
	How did your company evaluate competing companies on the same project in terms of criteria and process?
	What was the most important factor in the evaluation?
	What were the common interests between competitors? Were there any potentially conflicting interests?
	When would your company decline collaboration with competitors for innovation?

Outcome	What was the main reason for your company to accept the invitation to join the project? Who made the final decision? Were there any competitors who did not accept the invitation?
Current status of the project	What is the current status of the project?

Appendix C: Example of coding tension sources in the pre-project phase (Paper 2)

The first step in coding: Descriptive codes about the sources of tensions	The second step in coding: Categories according to Smith and Lewis's (2011) classification of organizational paradoxes	Theme that emerged
Risk-averse managers		
Managers rely on rewards		
The most effective way to use resources	Performing paradoxes	
Resources allocated to internal innovation		
Resources allocated to collaborative innovation		Intra-organizational tensions
U.S. ownership and top management		
Norwegian ownership and top management		
Open Norwegian organizational culture		
Closed U.S. organizational culture	Organizing paradoxes	
The idea is a dangerous thing		
Buy research; don't collaborate		
Top-down decision-making process		
The long-lasting boreoarctic decision-making process		
Decisions made by headquarters		

Many hierarchical levels inside the company		
Close to core knowledge Changing competitive edge Who has the right to patent? When can companies patent? How can patents be shared? Control over background information Which data can be shared? Rules for selective data sharing Rules for data protection	Learning paradoxes	Inter-organizational tensions

Part II: Individual papers

Paper 1

Is Being Invited for 'Dinner with Competitors' in Coopetitive R&D Projects a Good Opportunity?

Sanja Smiljic, Tor-Helge Aas, Anne-Laure Mention

Abstract

The importance of appropriate partner selection is widely recognized in the R&D management literature. This study departs from the perspective of focal firms selecting partners to uncover the evaluation process undertaken by companies in mature industries, invited to join coopetitive R&D projects involving multiple actors—competitors, research partners, suppliers, and customers. Prior research has primarily examined coopetitive and non-coopetitive innovation partnerships separately, mostly from an alliance or firm perspective. We go beyond the coopetitive dyad and qualitatively explore six coopetitive R&D projects in mature industries, with both competitors and non-competitors participating. The findings suggest a complex multi-step evaluation process of competing companies invited to join such projects. Understanding this process is particularly important for attracting coopetitive partners when the benefits of joining a project are not clear, since it reveals the criteria adopted in each step and the critical points and possible outcomes of the evaluation process. Our findings enrich knowledge of how to attract partners for coopetitive R&D collaborations in mature industries and advance theory by offering propositions that can be tested in future empirical studies. Establishing coopetitive R&D projects is usually challenging, and this study provides guidance for practitioners who consider embarking on a coopetitive journey.

Keywords: Coopetition; R&D projects; Partner evaluation; Partner selection; Partner attraction; Mature industries

1 Introduction

Research and development (R&D) collaborations are increasingly perceived as a means to achieve companies' complex innovation goals and keep pace with today's technological imperatives (Jakobsen, 2020). The literature has mainly analysed dyadic R&D collaborations with either research or market partners (Du

et al., 2014), but attention is now being directed to multi-partner R&D collaborations involving competitive and non-competitive partners (Ritala et al., 2017; Yang, 2020). When it comes to coopetitive R&D partnerships in particular, scholars have argued that the presence of research institutions, suppliers or customers may enhance benefits while increasing the complexity and challenges of managing coopetition (Yami and Nemeh, 2014; Henttonen et al., 2016). Consequently, scholars claim non-transferability of findings from dyadic R&D relationships and call for more research on establishing and managing complex multi-partner R&D collaborations (Ritala et al., 2017; Yang, 2020; Yang et al., 2020).

According to Doz et al. (2000), how R&D collaborations are formed can more significantly influence expectations, relations and outcomes than their later organisation. While most previous research has treated formation as a focal firm selecting other partners, Borch and Solesvik (2016) and Jakobsen (2020) note that in some industrial contexts like mature industries, the benefits of multi-partner R&D collaborations may not be clear in advance. Therefore, they call for shifting focus from partner selection to partner attraction, acknowledging that prospective partners might not always be willing to join or may decide to exit after joining.

This important perspective has also been recognized in other research streams; in innovation ecosystem research, for example, the increased complexity of interactions and need to better understand those ecosystems has directed attention to better articulation of the role of non-orchestrators, which is one of recently indicated research gaps (Yaghmaie and Vanhaverbeke, 2020). Dedehayir et al. (2018) delineate the specific roles of ecosystem leaders, suppliers, users, experts and champions, sponsors and regulators in ecosystem formation. Similarly, the project management literature acknowledges the limited authority of coordinators in multi-partner, EU-funded projects (vom Brocke and Lippe, 2015). While the perspective of the coordinating organization remains dominant, scholars call for more focus on non-orchestrators i.e. other members of those projects and their roles (Enger and Gulbrandsen, 2020).

While knowledge about R&D networks and alliances abounds, innovation and coopetition scholars call for more research into coopetitive innovation projects (West and Bogers, 2017). Innovation project participants unite to reach targeted goals more quickly (Culpan, 2014; Du et al., 2014). The same company may behave differently in different projects in terms of technology, resources and

project management styles (Cassiman et al., 2010). Therefore, by adopting a project perspective, this paper deepens our knowledge of the establishment of coopetitive R&D collaborations.

Coopetitive collaborations have most frequently been explored in emergent industries (Zakrzewska-Bielawska, 2015). Scholars have identified the differences in university–industry R&D collaborations among emergent and mature industries in terms of innovation process, knowledge, and ways and goals of collaborating with scientific partners (Bodas Freitas et al., 2013). According to Ciravegna and Maielli (2011) collaboration for innovation in more closed mature industries requires adapting organizational structures, roles and processes and carries greater risks of eroding companies' knowledge. Those factors might affect the evaluation process and willingness of companies in mature industries to join coopetitive R&D projects, so mature industries are a particularly productive context for this study.

Given the complexity and uncertainty of multi-partner coopetitive R&D projects, we acknowledge that not all companies in mature industries may be equally willing to join those projects or equally successful in coping with their challenges (Yang, 2020). We thus argue that to attract the best partners and mitigate collaboration challenges, we need to understand the evaluation process performed by competitors invited to join coopetitive R&D projects and thus in a reactive position when assessing a proposal from those who 'host the dinner'. Furthermore, our research goes beyond the competitor-to-competitor dyad and recognizes the – often neglected – possibility that non-competing actors may influence their decisions. This is particularly important now due to the increased focus of both industry and policymakers on complex multi-partner R&D collaborations as a way to address current technological challenges (Jakobsen, 2020; Yang, 2020). Hence, we use a case research methodology to analyse six mature-industry R&D projects that include competing and non-competing companies, research partners and at least one other partner (supplier, customer or cluster), to answer the following research question: How do firms in mature industries evaluate invitations to join coopetitive R&D projects?

Our findings reveal a multi-step process. Each step is based on specific set of criteria, and different degrees of compliance may lead to different outcomes. Detailing this evaluation process provides valuable theoretical insights for R&D, innovation management and coopetition research and has important practical

implications for companies, project managers and other actors in this type of project.

2 Literature Review

2.1 Partner selection for R&D projects

Firms typically innovate through R&D projects (Cassiman et al., 2010), defined as 'temporary entities that conduct a series of complex and interrelated activities with predefined goals' (Du et al., 2014, p. 829). The increased costs and risks and greater knowledge and resources needed for intensified technological innovations 'force' engagement in R&D collaboration with external partners nowadays (Ritala and Sainio, 2014; Cho and Lee, 2019).

Different R&D partnerships may bring different benefits; indeed, not all benefit companies' innovation performance (Pippel, 2015). The literature distinguishes between research-based collaboration with universities or research institutions and market-based collaboration with suppliers, customers or competitors (Du et al., 2014). Market and research partners play important but different roles in R&D projects and provide different types of knowledge (Hoang and Rothaermel, 2005; Hamadi et al., 2018). Collaboration with research partners carries lower risks and costs and results in scientific and technological knowledge (Tether, 2002). Collaboration with market-based partners is accompanied by higher risks and provides market knowledge helpful in solving problems, entering new markets and satisfying customers' needs (Du et al., 2014).

However, not all R&D projects are dyadic; some include science partners, suppliers, customers or competitors (Cassiman et al., 2010), and scholars claim that findings from dyadic relationships cannot be transferred to multi-partner contexts (Czakon and Czernek, 2016; Tidström and Rajala, 2016). Involving multiple partners may enhance project benefits. For instance, the presence of non-competitors may improve synergies and the integration of competing companies' knowledge and technology (Yang, 2020). Studies have also revealed the increased relational complexity of multi-partner R&D projects: intense knowledge sharing and protection and coopetitive, organizational and managerial issues (Henttonen et al., 2016; Ritala et al., 2017; Du et al., 2020). Those challenges may be addressed by appropriate project organization, engagement and communication (Mishra et al., 2015), relational or contractual governance modes (Barbic et al., 2016; Du et

al., 2020), and knowledge sharing and integration mechanisms to manage tensions (Santos et al., 2012; Henttonen et al., 2016).

Successful collaborative R&D requires partners to collaborate and share knowledge (Geum et al., 2013). Therefore, the scholars have mainly developed guidance for appropriate partner selection, typically in dyadic relationships and assuming that numerous companies would be willing to collaborate (Lee et al., 2016). Various criteria for assessment of potential partners have been suggested. Companies may select partners with the resources they need (Reuer and Devarakonda, 2017), or those that will not undermine the company's own resources (Li et al., 2008). Other suggested criteria are alignment of technology roadmaps (Lee et al., 2016) and the value creation abilities and incentives of potential partners (Diestre and Rajagopalan, 2012). Chen et al. (2010) suggest evaluating potential partners' strategy, costs, resources or learning motivation, while Geum et al. (2013) identify technology strength and R&D openness as basic criteria for strategic partner selection and R&D linkages and collaboration effects as relational characteristics. Borch and Solesvik (2016) suggest that partner selection depends on collaborative outcomes; the more tangible and precise an outcome, the broader the range of potential partners.

2.2 Partner Selection in the Coopetition Literature

The concept of coopetition was first introduced in the computer industry in the 1980s by Raymond John Noorda (Bouncken et al., 2015), and then broadly defined by Brandenburger and Nalebuff (1996) as a 'value net' process between suppliers, customers, competitors and complementors. Bengtsson and Kock define it as simultaneous competition and cooperation between two or more competitors (2000, 2014).

Coopetition is often discussed as paradoxical (Le Roy and Fernandez, 2015; Bengtsson et al., 2016), because competitors collaborate based on common interests while maintaining competition rooted in their own interests (Fernandez et al., 2014). Coopetitive collaboration carries a higher risk of knowledge leaks and technology imitation and may lead to a weakened market position (Gnyawali and Park, 2011). Consequently, the coopetition literature has recognized appropriate partner selection as crucial (Kraus et al., 2018).

The coopetition research stream has analysed partner selection criteria, processes and models mainly from the perspective of companies that invite others

to form alliances (Alves and Meneses, 2015; Kraus et al., 2018). The first approach in the alliance literature was introduced by Geringer (1991), who distinguished between task-related criteria like complementarity of resources and skills (Kraus et al., 2018) and partner-related criteria like compatibility of goals, trust, commitment and risk (Alves and Meneses, 2015). Later, Cummings and Holmberg (2012) identified two more criteria: learning-related criteria that enable knowledge transfer and risk-related criteria associated with performance, relationships and environmental risks. Akdoğan et al. (2015) point out the importance of trust, commitment and mutual benefits, while Alves and Meneses (2015) identify three steps in partner selection for coopetitive alliances: socialization between managers, ideation to cooperate and refinement of partner selection to join a formal alliance. Zakrzewska-Bielawska (2015) found that companies in emergent industries chose similar-sized coopetitive partners with similar technology and market position or demonstrably larger firms. While Chiambaretto et al. (2020), indicated that the choice may be dependent of particular motivation: small companies choose cooperation with bigger competitors to reduce the costs and increase learning possibilities; large companies would choose smaller competitors if there is opportunity to reduce time-to-market. Similarly, when it comes to risk-related criteria, experienced firms (those with accumulated learning from experience) are more willing to select close competitors than inexperienced firms (Chiambaretto et.al. 2019).

Coopetitive R&D partnerships have received limited scholarly attention that has often overlooked the possibility of simultaneously engaging competitive and non-competitive partners, although Le Roy et al. (2016) analysed the suitability of competing and non-competing partners for either incremental or radical product innovation. Furthermore, most studies concerning partner selection in the coopetition research stream have a common starting point: the criteria applied by companies actively seeking partners. How much do we know about the evaluation process performed by reactive companies, with limited ability to influence the choice of other partners in situations when the benefits of collaboration are not obvious, that are chosen as potential partners? Only a very few studies have examined partner selection in coopetitive R&D projects from this perspective. Nemeh and Yami (2016) outline the broad conditions that need to be met for coopetition strategy to emerge in R&D, such as a favourable context with unified research-oriented objectives, consistency with firm's strategy and the project

portfolio. Significant prior experience in coopetitive R&D collaborations was found to be important for companies' decisions to engage in inter-network coopetition, while less previous experience leads to engagement in R&D collaborations within firms' own coopetitive networks (Schiavone and Simoni, 2011). Czakon and Czernek (2016) revealed that third-party legitimization and reputation influenced the responses of competing companies invited to enter into network coopetition. However, they studies the tourism industry, so transferability of results is not straightforward.

2.3 The Context of Mature Industries

Emergent industries have been the context for most empirical coopetition studies (Pellegrin-Boucher et al., 2018), and scholars report that context influences knowledge creation and dissemination in R&D projects (Du et al., 2014). The focus of the present study is on mature industries that have passed the emergence and growth phases but have not yet reached the decline phase. As markets and technology mature, companies tend to switch from product innovation to process innovation strategy (Dosi and Nelson, 2013), and to remain competitive, they cannot innovate based only on internal innovation practices (Chiaroni et al., 2010). Since the transition from internal to collaborative innovation in mature industries requires changing organizational structures, processes, and inter-organizational relationships (Chiaroni et al., 2010), these companies face challenges in adapting internal practices to incorporate external knowledge (Ciravegna and Maielli, 2011).

Moreover, scholars have suggested differences in innovation processes and knowledge used in mature emergent industries (Chiaroni et al., 2010; Bodas Freitas et al., 2013). For instance, collaboration with research partners in emergent industries is often established based on new informal contacts and aims for new knowledge generation, while this type of collaboration in mature industries is often initiated by existing contacts and aims to better integrate technology and embodied knowledge (Bodas Freitas et al., 2013). Borch and Solesvik (2016) indicate that the benefits of collaborative R&D projects in mature industries are not always visible, making their attractiveness less obvious and trust crucial to forming collaborative partnerships (Solesvik and Encheva, 2010). However, Borch and Solesvik (2016) examined R&D alliances in general, not coopetitive R&D collaborations.

Due to the peculiarities of mature industries, appropriately balancing collaborative and non-collaborative innovation practices still triggers much debate in that context (Caiazza, 2015). Therefore, the decision to engage in coopetitive R&D projects may expected to be challenging and complex, which makes understanding the evaluation processes of competing companies invited to join such projects in mature industries particularly relevant.

3 Research Methodology

3.1 Research Design and Case Selection

We adopted a case research methodology (Yin, 2009) to explore a complex phenomenon in a specific, real-life setting with the aim of theory building (Eisenhardt and Graebner, 2007). The chosen unit of analysis is the project. We strategically selected coopetitive R&D projects with multiple partners: competitors, suppliers, customers, universities and research institutes.

The starting point in sampling process was consulting with managers of a highly innovation- and collaboration-oriented business cluster in Norway. Cluster members included top-performing and world-leading competing providers of oil and maritime equipment. The consultations identified coopetitive R&D projects with at least one cluster company involved. This information was complemented with publicly available information which confirmed that all projects were R&D oriented and involved research partners (universities or research institutions), competing companies from mature industries, and at least one other partner(supplier, customer or business cluster). All six identified projects were sampled for our study.

The projects had reached different phases: one was in the early phase, with companies still deciding whether to join, while five projects had already reached the implementation phase. Five projects were initiated by research or cluster partners and one by a competing business partner. In two projects, one competitor decided to leave the project, either during the early negotiation phase or later during the implementation phase. The characteristics of the selected projects are presented in Table 1.

Table 1: The sample

Project	Participants	Description	Funding	Type of informants	Number of interviews
A	Two competing companies, four non-competing companies, two customers, one university and one research institute. The project was initiated by one of the competing companies.	The aim was to develop new business models and services. The project was still in the early negotiation phase at the time of the first round of the interviews. It was decided that one competitor would not participate in the project just before our investigation began. Follow-up interviews were conducted since another competitor later joined the project.	The project was funded by the Research Council of Norway and the companies.	PM* HLM** Ue***, RIe****	5
B	Two competing companies, one customer, nine non-competing companies, seven universities and two research institutes. The project was initiated by the innovation hub.	The aim was to develop a new model for data sharing. The project was in the early negotiation phase at the time of the investigation.	The project was funded by the companies and Business Finland.	PM, HLM, MLM*****	3
C	Two competing companies,	The aim was to develop new business models. The project was in the implementation	The project was funded by the companies	PM, HLM, MLM,	6

	three non-competing companies, one university, one research institute and one business cluster. The project was initiated by the business cluster and the university.	phase, and one of the competing companies decided to leave the project just before our investigation began.	and the Research Council of Norway.	CM****** RIe	
D	Four competing companies, a few other non-competing companies, one business cluster and one university. The project was initiated by the university and the business cluster.	The aim was to develop and implement a new test laboratory. The project was in a later implementation phase at the time of our investigation.	The establishment of the laboratory was funded by the government; the companies committed to using the laboratory. The laboratory needed to function according to market principles and be self-sufficient.	PM, HLM, MLM, CM, RIe, Ue	9
E	40 member companies of the business cluster, among which were four competing companies, one customer, a few non-	The aim was to develop a new analysis model to comply with new environmental regulations. At the time of our investigation, the project was in a later implementation phase.	The project was funded by the companies and Innovation Norway.	PM CM, HLM, MLM, Ue	5

	competing companies, one cluster and one university.				
F	The project was initiated by the cluster and companies. Four competing companies, one customer, six non-competing companies, four universities, two research institutes and a business cluster. The project was initiated by a university.	The aim was to develop new technology. At the time of the investigation, the project had reached its mid-term evaluation.	The project was funded by the companies and the Research Council of Norway.	PM, HLM, MLM, CM, Ue	13

* PM: Project manager
** HLM: High-level manager (CEO, vice president, R&D director)
***Ue: University employee
****RIe: Research institute employee
***** MLM: Mid-level manager
****** CM: Cluster manager

3.2 Data Collection

The sampling of key informants began by interviewing the manager of each case project. Subsequently, other informants were identified through snowballing.

This procedure proved valuable since informants' willingness to participate was based on trust, due to the sensitive nature of coopetition and because some informants belonged to elite groups (Atkinson and Flint, 2004). We conducted 42 semi-structured, in-depth interviews with decision-makers from high- and mid-level management of competing companies, project managers, cluster managers, and employees from research institutions. Follow-up interviews were conducted with some informants to clarify and enrich the findings. Detailed information on informants is provided in Table 1.

Thirty-two interviews were conducted face to face; ten with informants in other countries used conference calls. The interviews ran from 60 to 90 minutes. An interview guide (see Appendix B) was developed to ensure a common understanding of the phenomenon and the purpose of the questions. The guide consisted of several themes that were addressed through open-ended and follow-up questions:

company's collaborative innovation strategy and policy
partner evaluation criteria
decision-making process for innovation partnerships.

All interviews were audio recorded and transcribed promptly to avoid interpretation bias. During the interviews, we took notes about informants' reactions and explanations. In addition, publicly available data like project and company webpages and press releases were used to form a better understanding of the cases and prepare for the interviews.

3.3 Data Analysis

Inductive data analysis was performed in accordance with Miles et al.'s (2014) two-cycle coding logic, supported by the NVivo 12 software tool. In the first coding cycle, segments of data were descriptively summarized to identify all the activities, participants and criteria used by competing companies when evaluating invitations to join a sampled project. During this process, all insights that emerged from the data were noted. In the second coding cycle, we identified themes that helped group identified codes into explanatory categories. An iterative process of creating and revising codes continued until a sufficient level of understanding the data was reached. Appendix B presents an example of codes and themes that emerged during the coding. Coding was done by the first author, with all co-authors involved in the analysis, which involved presentations and reports from

the companies, annual project reports and publicly available information about both projects and companies to complement and contextualize the information from the interviews.

4 Findings

Our data revealed two main steps in the evaluation process of competing companies deciding whether to join coopetitive R&D projects in mature industries: (1) evaluation of project characteristics, and (2) evaluation of partners.

4.1 The First Step – Evaluating Project Characteristics

The projects in our sample were initiated by research partners, business clusters or companies. In many sampled projects, the initial idea came from a company, but the initiation process was conducted by a cluster or university that chose the companies to invite. The first step that invited companies performed was evaluating the project's characteristics. The employees involved in the evaluation process were senior managers responsible for the final decision and middle and technical managers with technical expertise and knowledge relevant for the projects: 'We are a committee that decides what kind of innovation projects we want to go for' (High-level company manager, Project F); 'That's people from the lower level; the technical people. I, as a CEO, often take the final decision' (High-level company manager, Project D).

The evaluation of project characteristics was based on four criteria, typically analysed in parallel. If all were satisfied, companies would proceed to the second step:

fit with company strategy
perceived benefit for end customer
perceived complexity of project
distance from core knowledge.

When invited to join, companies evaluated the project's fit with the company's strategy and business goals: 'We look at it from the management perspective … and how it links to our strategy and plans' (High-level company manager, Project B); 'Interest in the project is based on how it fits our strategy and agenda and business goals, so I think that is the critical thing' (Mid-level company manager, Project C). In some companies, evaluating the strategic fit caused tension between different managerial levels and different views of the people involved: 'Often you

see that the technical personnel have one perspective and would like to join, but the management says, “No, for strategic reasons we don't want to join”, so that can cause tensions within the company’ (High-level company manager, Project E); ‘Different opinions, maybe also different views on what is important for us’ (High-level company manager, Project D).

Our data showed that another important evaluation criterion was the perceived benefit of the project for end customers: ‘As soon as you have a customer on board, all the companies are immediately much more interested. I think that was the key’ (Project manager, Project E).

> If you do such a project, it's more or less a push from the customers, like oil companies, because they see the problem and they demand that we work together. … We see that our customers really don't want us to be the only owner of that technology; we know that our customers want an open marketplace. (Mid-level company manager, Project F)

A better understanding of the market as a means of enhancing market position and ensuring end customer benefit was also a motivation for joining the projects: ‘We are not developing concrete products; we are developing an understanding of the market and understanding the needs of the market’ (High-level company manager, Project F).

When evaluating project characteristics, companies also analysed the complexity of the project as an opportunity to create new technology and obtain research-based knowledge that they could not create alone: ‘The innovation lab is good for all of us, and that was a good example of how to build something together, because it's a benefit for the whole region’ (High-level company manager, Project D); ‘Those projects are about developing technology, enabling technology … then you can start the product development afterwards’ (High-level company manager, Project F).

> Because it's so difficult, so expensive, and challenging to develop your own complete, total technology platform, you need to cooperate … If every company wanted to establish its own test facilities, and piloting, that would be too expensive, even for the big ones, and especially for the smaller companies. (Research partner, Project D)

Some companies noted the benefits of involving their employees: ‘If we contribute with people doing actual work, and get people engaged, then all the

knowledge we develop in these research projects is more easily pulled back into the company' (High-level company manager, Project F).

During project evaluation, companies also assessed whether the scope of work was outside their core knowledge zone: 'What is generic, common knowledge, that we can share and that we can develop, that is not changing competition between our companies … a huge area of basic, common knowledge that we need to improve' (High-level company manager, Project D).

> We are open to this collaboration in certain areas, but in other areas we will not cooperate at all. … I would say that in areas where we have very, very specific markets or specific products, competencies we tend to stay out of cooperation with others. (High-level company manager, Project F)

A positive evaluation of all four criteria was required for companies to move to the second step.

4.2 The Second Step – Evaluation of Project Partners

Our data indicated that the second step was evaluating project partners, according to the following criteria:

(1) market position of competing companies which, for direct competitors, was followed by analyses of trust in research partners
time perspective in potential collaboration with competitors
size and power of competing companies.

Meeting the first two criteria typically led to a positive decision about joining the project, but the size and power of competing companies was not of equal importance in the projects where the involvement of various companies was a formal requirement.

4.2.1 Market Position of Competing Companies and Trust in Research Partners

The first step in partner evaluation was differentiating between direct and indirect competitors and assessing their market position. If companies were perceived as indirect competitors, companies were willing to collaborate and would proceed to the next evaluation step. When companies were perceived as direct competitors, three types of reactions were identified: 1) an unwillingness to collaborate; 2) evaluation of the trust in research partners and 3) the requirement for a separate unit within the same project. Elaborations on the outcome of each

reaction follow.

The first type of reaction appeared in project A, which was initiated by a firm; one of the companies decided not to allow direct competitors to join the project.

> What we were looking into was how they are placed in the markets we are operating in, if those companies are not directly competing with us, because we would like to enter into other markets and learn from that. I don't think we have that much to gain from companies working as direct competitors within this project. (High-level company manager, Project A)

The second type of reaction was identified in projects where companies, faced with direct competitors, evaluated their trust in the putative research partners. Some competing companies perceived research partners as neutral and trustworthy partner that might protect their interests and decided to participate despite being aware that a direct competitor was involved: 'There is a difference, because the university is always a neutral partner in that work. The university has no relationship to any customer, or specific customer need, or specific manufacturer need. They concentrate on the common challenges in the middle' (High-level company manager, Project D); 'The big challenge is that we really compete on the same projects, all the time. It's not that we have a different share of the market; we are on the same projects. … But we have decided to join because of the trust that researchers, if we share something with them that we feel is very confidential, will protect that' (High-level company manager, Project F).

However, our data indicated variations in the level of trust in research partners rooted in companies' knowledge and understanding of R&D projects and previous experiences in collaboration with research partners. Some companies had higher levels of trust based on their previous collaborative experiences: 'We have a long tradition of doing this kind of industry-academia type of collaboration, and we do have it in our field of business for sure' (High-level company manager, Project B). Other companies had concerns related to publishing processes that had to be regulated: 'The concern for sharing information? It's related to other companies, of course, but also, we understand that researchers need to publish these results. There was some concern about publishing by researchers' (High-level company manager, Project F). Some companies lacked any experience with R&D collaboration with research partners.

> The industry still doesn't really know what research is; they know about product development. … I haven't really heard anybody explaining to the

> industry what the difference is. What is the difference in approaching new product development, compared to R&D? It isn't explained to them; it's hardly explained anywhere. Research is often thought of as just words and fairy tales, but new product development is something you can sell in 18 months, to get paid. (Mid-level company manager, Project F)

Lastly, the third type of reaction appeared in Project B where companies participated in the same overall project but required separate units:

> Evaluation of how they are competing today with us. … Our main intention was to have participants from different businesses. … Both companies want to have their own, let's say, small ecosystem in the project, because we know how difficult it is to actually share information. (Mid-level company manager, Project B)

To summarize, when companies were perceived as direct competitors, trust in research partners or the possibility of separation within the same project were perceived as enough to proceed to the third partner evaluation criterion.

4.2.2 Time Perspective in Potential Collaboration with Competitors

The third evaluated aspect was the timeline of potential collaboration with competitors. The possibility of long-lasting collaborative relationships was viewed as important.

> I would say that their strategic fit for the long term is kind of important. We see that this competitor might be our partner for a long time, at least three to five years. It's hard to see more than three years [ahead], but then at least we need to see more than one project. (High-level company manager, Project C)

All companies involved in the projects were members of a cluster and had been involved in previous projects. That record of coopetitive collaboration seemed to positively influence evaluating the potential for long-lasting collaborative relationships: this type of collaboration ‘is something that has been there for several years. It has evolved and developed in a way, so the rules of the game are already familiar to everybody’ (Mid-level company manager, Project B); ‘The companies have been representing themselves together in the cluster for a long time, so we didn't start from scratch; they all knew each other, and I think they knew how far they could go’ (Member of project management team, Project F). Therefore, perceived potential for long-term collaboration with competitors,

enhanced by previous collaboration experience was sufficient to proceed to the last evaluation criterion.

4.2.3 Size and Power of Competing Companies

The last criterion adopted in evaluating external partners was their size and power. In most projects, companies gave priority to collaborating with partners of similar size, which was perceived as ensuring the contribution of all partners and a fair distribution of the results: 'If you are pretty much equal in size, you can have an equal amount of resources, financing, and time' (High-level company manager, Project F).

> The smaller company would learn faster from us. I would assume that the smaller player would actually learn quite a lot from that in a fast manner, but if it's about the same size, I think we, in a way, both know the same things and have experience. (High-level company manager, Project B)

However, in some projects, there was a legal requirement to include smaller companies, so this criterion was irrelevant: 'This type of program has also to benefit smaller companies, and there is this type of mechanism that, from the overall budget, some percentage needs to be allocated to subcontracting to small- and medium-sized companies' (Project manager, Project B).

4.3 Summary of the findings

The evaluation process that emerged from the findings is presented in Figure 1 and is discussed in detail below.

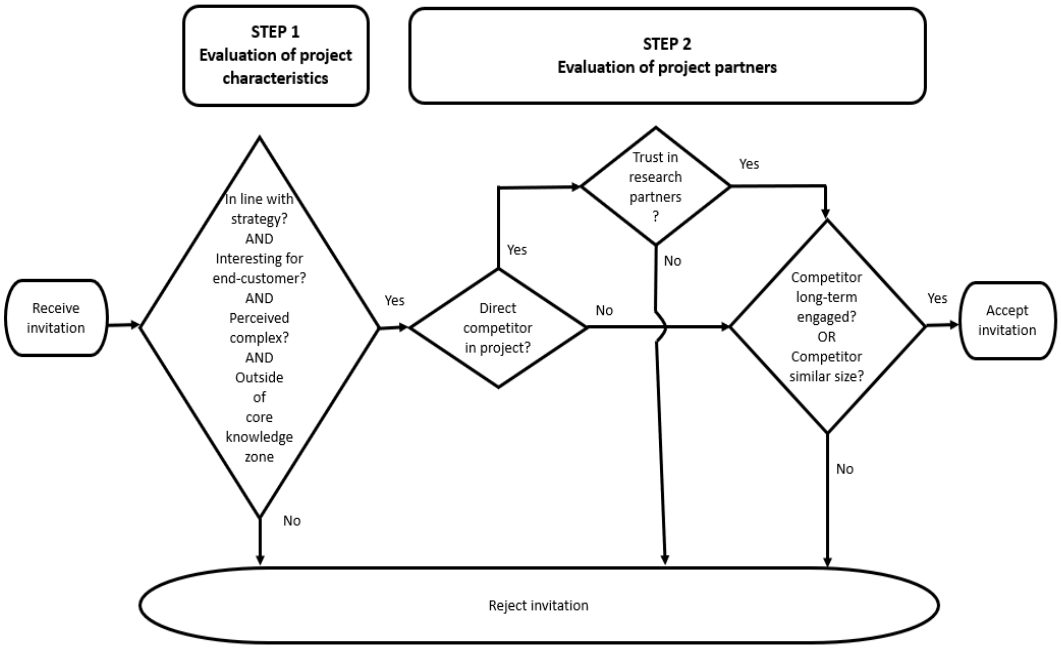

Figure 1: The process of evaluation of an invitation to participate in coopetitive R&D projects

5 Discussion

Most previous R&D and coopetition studies explore partner selection performed by focal companies in emergent industries. This paper focuses on the evaluation processes of mature-industry competing companies that are invited to join R&D projects that also include research partners, suppliers or customers. The findings revealed a two-step evaluation process performed after competing companies received an invitation. Each step is based on certain criteria and can influence the final acceptance decision. Theoretical insights are discussed according to the steps in which they appear.

5.1 Evaluation of the Project Characteristics

The findings revealed that, instead of using strategic selection criteria for partners as Guertler and Lindemann (2016) suggest, competing companies analysed project fit with their strategy, goals and plans to ensure that resource allocation aligned with their strategic priorities (Martinsuo and Killen, 2014). These findings accord with Nemeh and Yami (2016), who cited alignment with firm strategy as one of the major determinants of the emergence of coopetitive R&D projects. Our insights also complement debates in the project management literature concerning strategic clarity and mutual collaboration between

managerial levels for quality decisions in innovation portfolio management (Unger et al., 2012; Kock and Gemünden, 2016).

Evaluation of R&D projects has been recognized as especially difficult due to their high level of novelty and lack of prior information, which may lead to higher levels of mid-project termination (Unger et al., 2012) that constitutes a waste of company resources (Alsudiri et al., 2013). Different opinions within companies about projects' strategic alignment therefore add to the few studies claiming that the benefits of participation in mature-industry, multi-partner R&D projects are not always clearly visible and company willingness not always high (Borch and Solesvik, 2016). Those divergent internal views may also reflect the challenges of balancing between collaborative and closed innovation in mature industries (Chiaroni et al., 2010).

Previous research revealed differences in collaboration with competitors and collaboration with suppliers, customers or universities (Mention, 2011; Le Roy et al., 2016; Nemeh and Yami, 2016). We have identified that perceived benefit for the end customer or the involvement of customers in multi-partner R&D projects had a strong motivational effect and was considered as an opportunity to better understand the needs and convince customers of companies' ability to provide desirable services or products. This is in line with the lead-user approach (von Hippel, 1986) and extends the findings of previous studies noting the influence of the customer on coopetitive relationships in the satellite (Fernandez et al., 2014), software (Pellegrin-Boucher et al., 2013), luxury industry (Depeyre et al., 2018) and tourism industries (Czakon and Czernek, 2016). The presence of end customers may mitigate the risks of developing inappropriate technology and enhance knowledge sharing between competitors in mature industries, which extends the findings of Nemeh and Yami (2016) and Ho and Ganesan (2013). Therefore, we propose:

> P1: A project's perceived benefits for the end customer or customer involvement in a project has a positive influence on the decisions of competing companies in mature industries to engage in coopetitive R&D projects.

Some of our findings align with dynamic capabilities theory, recognizing coopetition as a beneficial strategy for innovation that can lead to the development of dynamic capabilities (Ritala and Hurmelinna-Laukkanen, 2009; Gnyawali and Park, 2011; Fernandez et al., 2018). For instance, one important motivation for

companies to join this type of project was the perceived complexity reflected in the potential for obtaining resources and developing technological capabilities. This complements Nemeh and Yami (2016)'s findings that competitors prefer to collaborate on R&D projects for enabling technologies. Developing new technological capabilities through multi-partner R&D projects was assessed as more efficient than generating them alone, in line with the task-related criteria defined by Geringer (1991). While Reuer and Devarakonda (2017) found that companies select partners that have the resources they need, our findings revealed that competing companies assessed a project's potential for generating research-based knowledge, corresponding to the learning-related criteria defined by Cummings and Holmberg (2012). Furthermore, companies assessed research partners' creation potential rather than the creation potential of competitors (Diestre and Rajagopalan, 2012). Hence, we propose:

> P2: Perceived project complexity, in terms of resources required and research knowledge that might be obtained through the project, positively influence the willingness of competing companies in mature industries to engage in coopetitive R&D projects.

Our data indicated that companies in mature industries will typically engage in R&D projects with competitors if the project's scope is outside a company's core competences, which is perceived as a key source of competitive advantage (Tidström and Rajala, 2016). This does not completely align with the findings of Borch and Solesvik (2016), who state that broader and less tangible aims of multi-partner R&D alliances in mature industries are less attractive to potential partners than those with clear, tangible outcomes. The difference may be caused by the coopetitive nature of the sampled R&D projects, which, in mature industries, might require certain changes in a company's procedures and routines, collaboration skills and internal appropriation mechanisms (e.g. Ciravegna and Maielli, 2011; Henttonen et al., 2016), to mitigate opportunistic risks that could undermine core competences (Cygler et al., 2018; Fernandez et al., 2018). Lastly, while Li et al. (2008) argue that companies select R&D partners that will not endanger their resources, we found that invited companies mitigate those risks by regulating the project's scope of work. Thus, we propose:

> P3: A project scope outside a company's core competency positively influences the willingness of competing companies in mature industries to engage in coopetitive R&D projects.

5.2 Evaluation of Project Partners

This step corresponds to partner-related criteria (Geringer, 1991), and the theoretical insights discussed below are an assessment of the market position of competing companies, the time perspective of a potential collaboration and the size of competing partners.

Like Kraus et al. (2018), our data indicated that competing companies in mature industries consider indirect competitors more attractive for collaboration than direct competitors. This finding may be context-specific since the challenges that mature-industry firms face in transitioning from internal to collaborative innovation practices (Chiaroni et al., 2010) discourage them from collaborating with direct competitors. However, our data indicated that in some projects, when invited to collaborate with direct competitors, companies that found the research partner trustworthy accepted the invitation to join. This reveals that trust in research partners mitigates perceived risks when establishing coopetitive R&D projects with direct competitors in mature industries.

Trust and previous collaboration experience have been identified as the most important criteria for partner selection in the coopetition literature (Akdoğan et al., 2015; de Resende et al., 2018), strategic innovation alliances (Gattringer et al., 2017) and in the context of mature industries (Solesvik and Westhead, 2010). Furthermore, Chiambaretto et al. (2019), indicate that experiences firms are more likely to collaborate with direct competitors, than inexperienced forms. We contribute to these discussions by revealing that a trusted research partner that would protect a company's interests and knowledge was more important than previous experience with competitors. In the same manner as the importance of third-party reputation and legitimization for joining coopetitive networks in the tourism sector (Czakon and Czernek, 2016), our findings suggest that trust in research partners is essential for decisions to join mature-industry coopetitive R&D projects. However, when competing companies were not familiar with R&D projects, it was more difficult to convince top management to join a project that aligns with the importance of R&D openness in mature industries indicated by Geum et al. (2013). Therefore, we offer the fourth proposition:

> P4: Trust and mutual understanding with research partners increase the willingness of competing companies to participate in coopetitive R&D projects with direct competitors in mature industries.

Our data indicated the importance of time perspectives when evaluating competitors. Companies were more willing to engage in long-term R&D partnerships due to the perceived likelihood of obtaining greater collaboration benefits; similarly, Cygler et al. (2018) reported higher innovation benefits and lower costs in long-term projects. Furthermore, partners oriented to the short term may be perceived as overly opportunistic (Das and Teng, 2000) or risk averse and unwilling to invest in projects (Borch and Solesvik, 2016). The project management literature has also acknowledged that longer collaboration increases trust and may lessen opportunism (Dietrich et al., 2010).

Additionally, previous participation with competing partners in similar projects positively influenced decisions to join. This contradicts Li et al.'s (2008) claims that frequent collaboration with certain R&D partners makes a firm's core knowledge vulnerable to opportunistic behaviour that firms may thus be more willing to collaborate with strangers. Our findings are in line with Love et al's. (2014) findings concerning the learning effect and positive outcomes that previous innovative collaboration have on the choice of partners and the management of future collaborative relationships (Dietrich et al., 2010). Solesvik and Gulbrandsen (2013) claim that companies in mature industries following effectuation logic tend to collaborate with partners that they already know, so we offer the fifth proposition:

> P5: The potential for long-term collaboration with competitors and previous collaboration with them on similar projects positively influence the decision of competing companies to join coopetitive R&D projects in mature industries.

Lastly, when exploring partner selection in R&D collaborations between large and small companies, scholars have pointed out different motivations for collaboration, such as market considerations for smaller firms and technological improvements for larger ones, along with differences in financial resources and technological capabilities (Lee et al., 2016). Chiambaretto et al. (2020), however, indicated cost-reduction and learning motivation of small companies to collaborate with bigger competitors , while large companies select smaller competitors to reduce time-to-market. Our data indicated that competing companies in mature industries prefer collaboration with competitors of a similar size to ensure mutual benefits, similar levels of commitment and mitigation of the risk of asymmetry in the relationship. This is similar to findings of coopetition studies in emergent

industries (Akdoğan et al., 2015; Zakrzewska-Bielawska, 2015). However, satisfying this criterion was optional, since the involvement of smaller companies may be a feature of project funding requirements. Therefore, we offer this final proposition:

P6: The presence of competitors of similar size positively influence the willingness of competing companies in mature industries to engage in coopetitive R&D projects.

6 Conclusions and Implications

This study explored the evaluation process of competing companies in mature industries invited to join coopetitive R&D projects. Our data exposed a two-step evaluation model (Figure 1) in which each step relies on specific set of criteria. This paper contributes to the R&D, innovation and coopetition literature in several ways. First, it advances research into partner selection for collaborative innovation (Geum et al., 2013; Guertler and Lindemann, 2016; Kraus et al., 2018). In particular, it builds on debates about the attractiveness of multi-partner R&D collaborations (Borch and Solesvik, 2016; Ritala et al., 2017; Yang, 2020; Yang et al., 2020) by revealing how competing companies assess the invitation to join R&D projects. Second, it enhances the knowledge of coopetitive innovation projects beyond a coopetitive dyad (Rouyre and Fernandez, 2019; Yang, 2020) by revealing the peculiarities of projects involving several competing companies and non-competing partners. The paper indicates a new perspective on trust during the establishment of coopetitive relationships, indicating trust in research partners as a way to mitigate coopetitive risks that has to a limited degree been acknowledged in previous coopetition studies (e.g. Czakon and Czernek, 2016). Third, this paper explores coopetition in the under-researched context of mature industries and indicates major challenges when opening up for coopetitive R&D collaborations due to the more internal innovation orientation of companies (Solesvik and Encheva, 2010; Borch and Solesvik, 2016; Jakobsen, 2020). This research also reveals the possibility of mitigating opportunistic risks in projects in mature industries through long-term collaboration and collaboration with similar-sized partners. Lastly, the derived propositions can inform and lead to future empirical studies in both the R&D and coopetition research streams.

Our study may also guide and inform the actions of project managers, competing companies, research partners and all other actors initiating or

considering joining coopetitive R&D projects. Establishing such projects in mature industries may be particularly challenging for all partners and affect knowledge sharing and project outcomes (Geum et al., 2013; Borch and Solesvik, 2016). This study may guide the negotiation process by exposing two-step evaluation process of competing companies invited to join and the criteria applied in each step, enabling project managers and partners to avoid critical points that can imperil a project. For example, because of the more internally oriented innovation of companies in mature industries, they need to ensure strong benefits for the customers and a greater distance of the project's scope from their core knowledge. If project evaluation conditions are met, involvement of trusted research partners becomes critical to mitigate coopetitive risks, while longer potential for collaboration and similar size of the competing companies involved are key factors in the final step to a positive decision. This model also offers valuable solutions for better structuring such projects to mitigate drawbacks caused by the complexity and uncertainty of coopetitive R&D projects from the outset.

6.1 Limitations and Avenues for Future Research

This study has certain limitations. Due to our interest in coopetition, we focused on the evaluation process conducted by competing firms. We interviewed project managers and members of project management teams, who have high-level views and a sound understanding of the interrelationships between participating parties. However, given the complex project structure, interviews with other partners (e.g., suppliers or customers) would have enriched the insights. Moreover, given the mature-industry context, these findings cannot be fully generalized, and future research might compare the evaluation process in both mature and emergent industries. Another area of further research that emerged from our findings is the role of other actors in multi-partner coopetitive R&D projects and their influence on competitor-to-competitor relationships. From the university–industry perspective, scholars could enhance our knowledge of the outcomes of multi-partner coopetitive R&D projects and compare them with the outcomes of R&D projects without coopetitive elements. Scholars could also analyse the relationship between various R&D projects and the innovation performance of the companies involved. Similarly, opening up the R&D processes in the context of mature industries may require further research attention. Finally, empirical testing of the suggested propositions is also an option for building on this research.

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Appendix A: Interview guide

Interview Guide		
• *Short presentation outlining the purpose of the study*		
• *Declaration of confidentiality and use of the interview*		
Information about the interviewee (education and work experience)		
Informant	*Personal details*	
	Background	Can you tell me about yourself: Education, seniority and roles?
	Function in the project	Can you tell me about your position in the company? What is your role with regard to innovation projects and the one in which we are specifically interested?
Dimension		Questions
Innovation strategy and policy of the company		Does your company have a specific innovation strategy? Can you please explain?
		Does your company have a specific organizational unit for R&D, technological collaboration, etc.?
		How open is your company to innovative collaboration with others and with competitors? Answer on a scale from 1 (not open) to 5 (completely open).
		What do you see as the benefits and disadvantages of collaboration with competitors for innovation?
Decision-making process for a specific project		How often does your company participate in this type of R&D project with competitors involved?
		Who was the initiator of the project? Who invited your company to join the project?

	What was the overarching goal of the project?
	Who from your company was involved in negotiations? Who were the other participants in the negotiations?
	What was the mandate of the person from your company?
	What does the decision-making process look like in terms of actors, role, time frame and issues?
Partner selection criteria and process	What was the motive for your company to join this project?
	Does your company have specific requirements in the initiation phase?
	How did your company evaluate competing companies on the same project in terms of criteria and process?
	What was the most important factor in the evaluation?
	What were the common interests between competitors? Were there any potentially conflicting interests?
	When would your company decline collaboration with competitors for innovation?
Outcome	What was the main reason for your company to accept the invitation to join the project?
	Who made the final decision?
	Were there any competitors who did not accept the invitation?
Current status of the project	What is the current status of the project?

Appendix B: Example of coding

First step in coding	Second step in coding	Themes that emerge
Fit with company's plans and business goals	*Strategic fit*	*Evaluation of project characteristics*
Optimal utilization of resources		
Internal tensions		
The role of high-level managers		
Customer involvement	*Benefit for customers*	
Understanding of the market		
Research knowledge	*Project complexity*	
Development of new technology		
Access to resources		
Learning goals		
Distance from core knowledge	*Scope of work*	

Generic knowledge

Influence on
competitive edge

Paper 2

Coopetitive tensions across project phases: A paradox perspective

Sanja Smiljic, Tor-Helge Aas, Anne-Laure Mention

Abstract

Despite the ongoing academic debate about how tensions within and between organizations participating in coopetitive innovation projects can be managed, little attention has been paid to the management of those tensions across different project phases. This paper aims to address this gap by qualitatively exploring the nature of these tensions and their management in the pre-project phase, when coopetitive innovation projects are initiated and planned, and in the project implementation phase, when such projects are executed. The findings indicate that companies in mature industries may experience strong intra-organizational tensions during the pre-project phase that are rooted in performing and organizing paradoxes. These tensions may harm companies' participation in projects and need to be handled by a "working-through" strategy at the company level. In contrast, inter-organizational tensions emerge as the dominant type of tension in relationships between competing companies during the project implementation phase due to performing, organizing and learning paradoxes and need to be addressed by "working-through", "splitting-and-integration" and a combination of the two strategies, respectively. Propositions are offered as theoretical contributions and may serve as recommendations for practice.

Keywords: Coopetition; Mature industries; Tensions; Innovation project phases; Paradox theory

1 Introduction

Collaboration between competitors during innovation processes, also called coopetition for innovation, has received increased attention from researchers. Various industrial, relational and firm-specific drivers such as technological convergence and digitalization, shorter product life cycles and high research and development (R&D) costs motivate companies to engage in this type of collaboration (Raza-Ullah, Bengtsson, & Kock, 2014; Tidström, Ritala, &

Lainema, 2018). Due to the high level of technological similarity and complementarity between competing companies, this type of collaboration can be valuable from an innovation perspective (Mention, 2011). However, the simultaneous contradictory logic of interaction between partners in coopetition (Y. Luo, 2007) often implies certain tensions both between and within the organizations involved (Tidström, 2014).

According to paradox theory, organizational tensions emerge as a result of paradoxes in the form of "contradictory yet interrelated elements that exist simultaneously" (Smith & Lewis, 2011, p. 382). In coopetitive relationships, managers and employees are faced with multiple contradictory elements (Raza-Ullah, 2020), such as demands to simultaneously compete and collaborate (Bengtsson & Kock, 2000), create and capture value (Ritala & Tidström, 2014) and protect and share knowledge (Jarvenpaa & Majchrzak, 2016). The literature suggests that the success of a coopetitive relationship depends on appropriately managing the tensions caused by these paradoxes (e.g., Fernandez, Le Roy, & Chiambaretto, 2018), and there are ongoing scholarly debates about specific types of tensions and their management (Bengtsson, Raza-Ullah, & Vanyushyn, 2016b; Le Roy & Fernandez, 2015; Raza-Ullah et al., 2014).

While early coopetition research focused on tensions in coopetitive alliances in general (Bengtsson et al., 2016b), more recent studies have started to investigate tensions and their management at the innovation project level, where they often emerge (Fernandez & Chiambaretto, 2016). Deepening our understanding of tensions at the project level is important since innovation projects differ in many aspects (Du, Leten, & Vanhaverbeke, 2014) and may therefore require diverse management practices (Cassiman, Di Guardo, & Valentini, 2010), especially concerning knowledge sharing and protection (d'Armagnac, Geraudel, & Salvetat, 2019). Empirical research has established that the management of coopetitive tensions is contingent on the risk profile of the innovation project, with high-risk projects requiring the establishment of a coopetitive project team and low-risk projects accommodating separated project teams (Fernandez et al., 2018).

However, while research in this area is maturing, there has been little focus on how the different phases of coopetitive innovation projects affect tensions and tension management. When investigating coopetitive innovation projects, scholars have largely focused on the project implementation phase (Fernandez et al., 2018), so we lack insights into tensions in the pre-project phase and how they and their

management differ from what is found in the implementation phase. This gap is disconcerting since the innovation management literature recognizes that the characteristics of the pre-project and project implementation phases differ widely for innovation projects (e.g., Poskela & Martinsuo, 2009). For example, while the pre-project phase is often fuzzy and chaotic with a high level of uncertainty, the project implementation phase tends to be more structured and have a lower level of uncertainty (e.g., Christiansen & Varnes, 2009). We argue that differences like this are likely to affect the tensions that participating firms experience in different project phases.

The literature also emphasizes the importance of the pre-project phase for shaping entire projects, influencing their quality and enhancing value creation (Edkins, Geraldi, Morris, & Smith, 2013). Scholars caution that mistakes in the pre-project phase can diminish or even endanger a project's outcomes, performance and value generation and call for special attention to this phase and its management (Floricel, Michela, & Piperca, 2016). With the aim of improving our knowledge of the underlying nature of coopetitive tensions, as called for in recent research (Gnyawali, Madhavan, He, & Bengtsson, 2016), we therefore focus on coopetitive tensions that emerge in the pre-project phase and compare them with those that appear in the project implementation phase.

We study this issue in the context of mature industries. Coopetition has seldom been studied in this context (Jakobsen, 2020), but echoing other authors (Bouncken, Fredrich, & Kraus, 2020; Gast, Gundolf, Harms, & Collado, 2019; Jakobsen, 2020; Mathias, Huyghe, Frid, & Galloway, 2018), we posit that empirical data from this context may be particularly relevant to improve our understanding of the nature of coopetitive tensions. As industries mature, companies start to search for external knowledge sources for innovation (Laursen & Salter, 2006), and collaboration with competitors becomes inevitable at a certain point (Bonel & Rocco, 2007). At the same time, companies in mature industries tend to rely more on employees' tacit knowledge and often face challenges when incorporating knowledge from external actors (Chiaroni, Chiesa, & Frattini, 2010; Ciravegna & Maielli, 2011). Therefore, finding the appropriate balance between internal and external knowledge sources has led to considerable debate in this context (Caiazza, 2015; Chiaroni et al., 2010). High industrial maturity, combined with increased costs and shrinking markets, has also been recognized as stimulating stronger competition between companies (Mathias et al., 2018;

Tidström & Rajala, 2016). Under those conditions, maintaining sustainable coopetitive relationships is challenging, and coopetitive tensions may become particularly visible.

Thus, to improve our understanding of how coopetitive tensions vary between different phases of innovation, we raise the following research questions in this paper: (1) How are tensions in the pre-project phase of coopetitive innovation projects in mature industries different from tensions in the implementation phase? (2) How can tensions in coopetitive innovation projects in mature industries be managed in the pre-project and implementation phases? To answer these questions, we use paradox theory (Smith & Lewis, 2011) as a lens to conduct an in-depth exploration of tensions and their management in five strategically sampled coopetitive innovation projects.

The paper is structured as follows: in the next section, we define the concept of coopetition and review the literature discussing organizational tensions and tensions that may arise in coopetitive relationships in the context of mature industries. Theoretical assumptions are developed in section 3, while section 4 describes the research methodology and data collection. The findings are reported in section 5 and discussed in section 6, which also offers avenues for future research. Section 7 concludes the paper.

2 Theoretical Background

2.1 The phenomenon of coopetition and its interplay with innovation processes

Brandenburger and Nalebuff (1996) increased awareness of the changes in business strategy based on new kinds of relationships between companies that they defined as a broad "value net" process involving suppliers, customers, competitors and complementors. A narrower definition was offered by Bengtsson and Kock (2000), who defined coopetition as simultaneous competition and cooperation between competitors and later (Bengtsson & Kock, 2014) acknowledged the involvement of not only two but several companies: "Therefore, we conclude that coopetition is a paradoxical relationship between two or more actors simultaneously involved in cooperative and competitive interactions, regardless of whether their relationship is horizontal or vertical" (p. 182).

Coopetitive collaborations may be pursued for innovation, to reduce costs and risks, sharing complementary knowledge and resources or penetrate new markets (Czakon, Mucha-Kuś, & Sołtysik, 2016; Roig-Tierno, Kraus, & Cruz, 2018; Trapp, Harris, Sanchez Rodrigues, & Sarkis, 2020); they can also be used for non-innovation purposes such as joint distribution, sales and marketing (Chiambaretto & Dumez, 2016; Pellegrin-Boucher, Le Roy, & Gurău, 2018). This study primarily builds on research into collaboration between competitors for innovation (e.g., Fernandez & Chiambaretto, 2016), which has attracted growing scholarly attention in recent years (Dorn, Schweiger, & Albers, 2016), and focuses on the tensions, interactions and dynamics of coopetition.

The benefits of coopetition for various types of innovation have been broadly established (Bouncken, Clauß, & Fredrich, 2016; Bouncken & Fredrich, 2012; Bouncken & Kraus, 2013), and scholars have further claimed that coopetition may be particularly beneficial in uncertain and dynamic markets and resource-limited environments (Roig-Tierno et al., 2018). However, due to its inherently paradoxical nature, which involves the duality of collaboration and competition (Czakon, Srivastava, Le Roy, & Gnyawali, 2020; Ritala, Kraus, & Bouncken, 2016), coopetition is typically accompanied by tensions and high risks of opportunism, technology imitation, knowledge leakage or weakening of market position (Gnyawali & Park, 2011). Therefore, appropriate management of coopetition tensions has been recognized as the main factor in successful coopetitive innovation projects (Fernandez et al., 2018).

2.2 Organizational tensions and paradox theory

A dynamic and highly competitive business environment, accompanied by globalization and technological pressures, poses a variety of challenges and contradictory demands to organizations (Margolis & Walsh, 2003; Smith & Tushman, 2005). To understand the nature and management of divergent demands, scholars increasingly use paradox theory, which, unlike other theoretical perspectives that focus on choosing between dualities, explores ways to simultaneously address competing demands (Smith & Lewis, 2011).

The underlying paradoxical nature has been acknowledged in several definitions of organizational tensions. Epstein, Buhovac, and Yuthas (2015), for instance, define tension as ‘‘two phenomena in a dynamic relationship that involve both competition and complementarity’’ (p. 3). Similarly, Hahn, Pinkse, Preuss,

and Figge (2015) explain tension as a paradoxical relationship between two poles of a paradox, while Smith and Lewis (2011) claim that paradoxical tensions appear due to the simultaneous existence of "contradictory but interrelated elements, logical individually but inconsistent or even absurd when combined" (p. 382).

Particular attention has been paid to the sources of divergent organizational tensions. The literature discusses conflicting aspects of corporate sustainability such as personal versus organizational sustainability agendas, short-term versus long-term corporate orientations, isomorphism versus structural and technological change and efficiency versus resilience (Hahn et al., 2015, p. 304) as some of the main sources of paradoxical organizational tensions. From a broader perspective, Smith and Lewis (2011) identify four basic categories of paradoxical tensions: those related to learning, belonging, organizing and performing. According to the authors, learning tensions appear as a response to changes, creativity and innovation, or the actions needed to address the future. Belonging tensions are related to individual and collective identity, membership and roles. Examples of organizing tensions are those between collaboration and competition, routine and change and control and flexibility, while the performing paradox arises due to the multiple and divergent goals of various stakeholders. In addition to tensions that are limited to one of the four main categories, additional categories appear in their intersection and at several levels: the individual, group, project or organization levels. They can also cascade between levels. Similarly,Wannags and Gold (2020), distinguish between tensions at the intra- and inter-organizational levels.

Tensions may evoke emotions such as anxiety, discomfort and stress and may lead to frustration and blockages (Putnam, Fairhurst, & Banghart, 2016); the management of divergent tensions has been recognized as one of the main determinants of an organization's fate (Smith & Lewis, 2011). Managerial responses to paradoxical tensions may be viewed through the lens of static equilibrium, in which the aim is to bring the system back into balance after an accidental event happen. For instance, Poole and Van de Ven's (1989) solutions range from accepting the consistency of the paradox and "living" with it, without the defense, to resolutions through spatial separations of dualities between different business units; temporal separation along different points in time, or synthesis as a solution that simultaneously accommodates both sides of the paradox. On the other hand, the dynamic equilibrium model offered by Smith and Lewis (2011) considers the system as a living, moving environment filled by both

inherent and socially constructed tensions. According to these authors, latent organizational tensions become salient for two reasons: the complexity of the external environment, which brings in change, plurality and scarcity and actors' paradoxical cognition and reaction when faced with divergent demands. Smith and Lewis's (2011) dynamic equilibrium model further proposes iterative managerial strategies for managing salient tensions: "(1) paradoxical resolution or confronting paradoxical tensions via iterating responses of splitting and integration [and] (2) acceptance or embracing paradoxical tensions via the strategy of working through" (p. 389).

2.3 Tensions in coopetitive innovation projects

One group of authors has built on the conflict management literature and perceives tensions as forms of conflict that can be avoided or solved (Bouncken et al., 2020; Tidström, 2014). Drawing on Fang, Chang, & Peng (2011, p. 774), Bouncken et al. (2020), define tension as "two co-existing contradictory forces with conflicting goals that are inherently connected to coopetition itself (p. 651)." Another group of the authors considers tensions to be integral to coopetition (Wilhelm, 2011), while a third builds on the paradox literature and perceives tensions as a result of the coopetition paradox (Bengtsson, Eriksson, & Wincent, 2010; Bengtsson et al., 2016b) that cannot be avoided or permanently resolved but only managed and balanced through actions undertaken by various partners (Fernandez, Le Roy, & Gnyawali, 2014; Raza-Ullah et al., 2014). Our study draws on this later stream of research and explores coopetitive tensions from the intra- and inter-organizational perspectives.

2.3.1 Types of tensions in coopetitive innovation projects

The management of tensions determines the outcomes and thus the success and failure of coopetitive collaborations; scholars have identified different sources of tensions and consequently argued for different management styles for tensions occurring at the inter- and intra-organizational levels (Devece, Ribeiro-Soriano, & Palacios-Marqués, 2019; Fernandez et al., 2014; Raza-Ullah et al., 2014). Two prevalent contradictory demands have been acknowledged as sources of tensions at the inter-organizational level (Vanyushyn, Bengtsson, Näsholm, & Boter, 2018). First, value creation versus value appropriation tensions appear when competitors jointly create "a pie" that is far greater than their individual contributions (Brandenburger & Nalebuff, 1996) and each tries to capture an

asymmetrical piece of it (Chiambaretto, Maurice, & Willinger, 2020). While the baseline model describes value creation and value appropriation as a linear process, scholars have more recently started to discuss it as a parallel, dynamic and iterative process where anticipated possibilities for value appropriation together with achieved appropriability constantly affect value creation (e.g., Bouncken, Fredrich, Ritala, & Kraus, 2017; Ritala & Hurmelinna-Laukkanen, 2018). Various factors may influence value creation and value appropriation tensions: 1) type of partner, as direct competitors may provide more balanced inputs for value creation and have similar opportunities for capturing value (Bouncken et al., 2020; Gnyawali & Park, 2011); 2) innovation phase and innovation type, as the earlier phases of radical innovation may lead to greater tensions due to the higher risks and uncertainties regarding outcomes at that stage, compared to the later launching phase or to incremental innovation (Bouncken, Fredrich, Ritala, & Kraus, 2018; Mele, 2011); 3) overarching coopetitive network structure, as positive and negative interdependences between the companies may lead to harmony or power asymmetry and tensions (Chou & Zolkiewski, 2018); and 4) different internal personal, social, cultural and other value systems of the partners (Mele, 2011).

Second, inter-organizational relationships may be considered a race for learning (Yang, Zheng, & Zaheer, 2015) that entails tensions around simultaneous knowledge sharing and knowledge protection (Gast et al. 2019; Jarvenpaa & Majchrzak, 2016; Morris, Kocak, & Özer, 2007). Sharing knowledge is crucial for value creation and the success of coopetitive collaborations, but knowledge also represents a source of companies' competitive advantage that requires appropriate protection (Ritala et al., 2016; Rouyre & Fernandez, 2019). Competitors operate in the same or similar markets and typically have similar capabilities and knowledge, but they may have different learning and knowledge-absorption capabilities (Dussauge, Garrette, & Mitchell, 2000; Fredrich, Bouncken, & Kraus, 2019). Therefore, the risks for opportunistic knowledge leaking and acquisition are deemed particularly high, and attention is paid to differentiating between critical and non-critical information and the mechanisms for handling both (Fernandez & Chiambaretto, 2016). Competitors may be more willing to share generic and project-specific knowledge, while protecting core, company-specific knowledge (Fernandez et al., 2014; Gast et al., 2019). Several factors may strengthen the intensity of knowledge sharing and protection tensions, including higher competitive overlap and complementarity of capabilities (Dussauge et al., 2000),

greater ambiguity (Tidström et al., 2018) and weak intellectual property mechanisms (Ritala & Hurmelinna-Laukkanen, 2013). Scholars have also identified the different importance of social ties, trust, physical proximity and plans and rules in different phases of coopetitive relationships (Mariani, 2016). Lastly, apart from the dualities noted above, there are strategic inter-organizational tensions (Tidström et al., 2018) rooted in the partners' different strategies and goals (Fernandez et al., 2014), different power and dependence (Jakobsen, 2020), conflicting roles (Bengtsson & Kock, 2000), and opportunistic behaviours (Osarenkhoe, 2010). At the inter-organizational level, scholars' attention has mainly been directed towards coopetitive tensions in inter-company alliances (Bouncken et al., 2016, 2017; Kim & Parkhe, 2009) and networks (Bengtsson & Kock, 2000; Madhavan & Gnyawali, 2004), with coopetitive innovation projects being addressed more recently (Fernandez et al., 2018).

Three main types of intra-organizational tensions are recognized: first, tensions related to internal competition for resources between different business units (Arvidsson, 2009; Chiambaretto, Massé, & Mirc, 2019; X. Luo, Slotegraaf, & Pan, 2006; Tsai, 2002); second, tensions resulting from inter-organizational tensions spilling over to lower levels within organizations due to different views among the various managerial levels on the value of coopetitive relationships with other companies (Bengtsson et al., 2016b; Raza-Ullah et al., 2014); and third, individual tensions, which are typically understood as cognitive and emotional tensions between employees in competing companies who might find it challenging to regard each other as partners (Gnyawali & Park, 2011), thus leading to a state of emotional ambivalence (Raza-Ullah, 2017).

2.3.2 Management of tensions in coopetitive innovation projects

Different management styles have been suggested for inter- and intra-organizational tensions. Le Roy and Fernandez (2015) indicate that the management of inter-organizational tensions requires a separation principle on the organizational level, an integration principle on the individual level and a co-management principle on the working group level. Similarly, Fernandez et al. (2018) found that the establishment of a coopetitive project team is appropriate for projects with high risks and high costs that lead to radical innovation, while the establishment of a separated project team is an appropriate for incremental, low-risk and low-cost projects. Cassiman, Di Guardo, and Valentini (2009) argue that the type of knowledge created in coopetitive R&D projects determines the choice

among internal, co-operative or contracting modes of governance. When managing information tensions between competitors, formal control mechanisms were found necessary to differentiate between critical and non-critical information, while handling critical information requires using both formal and informal mechanisms (Fernandez & Chiambaretto, 2016). Gast et al. (2019) indicate that balancing knowledge sharing and knowledge protection needs to be achieved by combining both formal and informal protection mechanisms. Additionally, information systems and digital technology have recently been recognized as enablers for more efficient knowledge sharing (Bouncken & Barwinski, 2021; Fernandez & Chiambaretto, 2016; Randolph, Hu, & Silvernail, 2020), while d'Armagnac et al. (2019), for instance, indicate that different sharing and protection mechanisms may be needed for temporarily coopetitive relationships such as projects, as opposed to alliances and long-term collaborations.

When exploring the management of intra-organizational tensions, scholars argue that companies cannot influence the coopetition paradox at the collaboration level, since many different factors can influence it, and discuss capabilities at the company level to manage internal tensions that this paradox creates for firms (Bengtsson & Raza-Ullah, 2016). It has been argued that this type of tension needs to be solved by top managers with certain capabilities: to understand, communicate across the organization, prioritize and allocate or reallocate resources properly (Bengtsson et al., 2016b) or, as Eisenhardt, Furr, and Bingham (2010) describe it, ambidextrous management. Klimas (2016), on the other hand, found that a hierarchical organizational structure, formalization and standardization applied within companies minimize the risks, internal tensions and negative consequences of collaborating with competitors. As informal internal mechanisms, these authors also note the importance of building an organizational culture characterized by engagement, loyalty, trust and commitment (Gast et al., 2019).

2.4 Project lifecycle phases

The project management literature often distinguishes between generic project lifecycle phases such as initiation, planning, execution or implementation and finalization (Besner & Hobbs, 2006). Success factors in terms of required leadership styles, project management practices and tools (Besner & Hobbs, 2006; Ng & Walker, 2008), change management activities (Vuorinen & Martinsuo, 2019), and transition rituals and strategic practices (van den Ende & van Marrewijk, 2014) differ across project phases (Brandon & Guimaraes, 2016).

Today's complex and dynamic environment challenges projects' successful outcomes and has drawn the attention of the project management literature to the early project phase (Jalali Sohi, Bosch-Rekveldt, & Hertogh, 2019), which is often called the pre-project phase (e.g., Hill, Russell, & Smith, 1988) or the front-end project phase (e.g., Edkins et al., 2013). The pre-project phase includes all activities that precede the project implementation phase (Labuschagne & Brent, 2005): framing the project idea, negotiation, development of a consortium agreement, establishment of the project structure and planning resources, activities and timelines (e.g., Besner & Hobbs, 2006). The pre-project phase has been recognized as crucial for the fate an entire project, influencing its quality and enhancing – or diminishing – its value creation (Edkins et al., 2013). Failures or mistakes in this phase can endanger the final outcomes, performance and value generation of a project, so particular attention needs to be paid to managing it (Kolltveit & Grønhaug, 2004).

The literature reveals several important characteristics of the pre-project phase. The level of uncertainty and risks in that phase are much higher than in later phases (Floricel et al., 2016). It has been called a fuzzy, ambiguous and chaotic phase in which the presence of various stakeholders and multiple interests may pose challenges to the understanding, positioning and alignment of the organizations participating in a project (Karlsson, Larsson, & Öhrwall Rönnbäck, 2018). In addition, creativity at the individual and group levels appears to be more important than during the implementation phase (Axtell et al., 2000). Therefore, addressing uncertainty and risks at the earliest opportunity (Floricel et al., 2016), integrating the organizations involved and managing their social interactions are the most important managerial tasks in the pre-project phase; they may require simultaneous multi-sided coordination and additional efforts directed towards collective identity building (Artto, Ahola, & Vartiainen, 2016).

Scholars suggest that there is no single way to organize and manage the pre-project phase, since the specifics may depend on the industrial sector, organizational context, type of market, innovation type and institutional, political and other factors (Edkins et al., 2013; Nobelius & Trygg, 2002). Therefore, even though there is a widespread understanding of the criticality of the pre-project phase, there are different views on the best management styles. Some scholars claim that a more flexible project management style based on an open and proactive attitude of project managers and adjustments in project organization can

keep a project in line with the environmental dynamics and changes that participating companies may face in the early project phases (Jalali Sohi et al., 2019; Nguyen, Killen, Kock, & Gemünden, 2018; Nobelius & Trygg, 2002). Similarly, Poskela and Martinsuo (2009) argue that formal rules and process management may undermine the creative nature of the activities and are therefore less important in the pre-project phase than in the project implementation phase. Other scholars, however, have identified the relevance of a more formal and conventionally "hard" project management style (Larsson, Eriksson, & Pesämaa, 2018), while Kock, Heising, and Gemünden (2016) and Koppenjan, Veeneman, van der Voort, ten Heuvelhof, and Leijten (2011) are among those who argue for the benefits of combining a certain level of flexibility and some degree of control to increase responsiveness to change in the pre-project phase.

According to the *Project Management Body of Knowledge Guide* (*PMBOK Guide*; Project Management Institute, 2013), the project implementation phase starts with the "kick-off" meeting. This is recognized as a relatively structured phase (Christiansen & Varnes, 2009) that has a lower level of uncertainty than the pre-project phase (Ettlie & Elsenbach, 2007). The key role in mitigating any resistance to change that may appear in an organization during the project implementation phase is played by persistence, stamina and intrinsic motivation (Farr, Sin, & Tesluk, 2003). Scholars have also noted higher importance of innovation-supportive organizational cultures, supervision and leadership styles (Axtell et al., 2000; Hammond, Neff, Farr, Schwall, & Zhao, 2011), along with formal process management and control (Christiansen & Varnes, 2009).

2.5 The underexplored context of mature industries

The literature acknowledges variations between innovation propensity and practices in different phases of the industry lifecycle (Bodas Freitas, Marques, & de Paula e Silva, 2013; McGahan & Silverman, 2001). As the industry becomes more mature, companies' strategies move from product orientation towards a more process-oriented approach, and firms start to search for different knowledge sources forinnovation (Laursen & Salter, 2006).

Coopetition for innovation has rarely been studied in the context of mature industries (Bouncken et al., 2020; Czakon & Rogalski, 2014; Jakobsen, 2020), in which technology and costs represent the main sources of competitive advantage (Tidström & Rajala, 2016). Consequently, companies may be more reluctant to

reveal core competencies and undermine their existing competitive positions. Scholars have even recognized high industrial maturity, followed by increased industrial costs and shrinking markets, as stimulating stronger competition between partners (Mathias et al., 2018; Tidström & Rajala, 2016). Under those conditions, maintaining sustainable coopetitive relationships in the long run is particularly important. According to Bonel and Rocco (2007), coopetition strategies become inevitable at a certain point in mature industries and require adjustments of firms' business models in line with their emerging interrelations with competitors. Mathias et al. (2018) reveal the importance of collective identity and collective norms for sustainable coopetitive collaborations, while Jakobsen (2020) discusses the relevance of structural dependence between companies in the early stages, while building trust and generosity gives rise to psychological dependence in the later stages of the alliance lifecycle. Formal coopetition strategies have been identified as particularly important for capturing value at the firm level in the case of mature small- and medium-sized enterprises (SMEs) (Bouncken et al., 2020).

3 Theoretical assumptions

This study explores and compares tensions and their management in two distinct project phases of coopetitive innovation projects: (1) the pre-project phase that includes initiation and planning (Hill et al., 1988), and (2) the implementation phase that starts with the kick-off meeting (Project Management Institute, 2013). The paradox theory, specifically Smith and Lewis's (2011) classification of paradoxical tensions, serves as the basis for developing broad theoretical assumptions related to the types of tensions that may appear in each phase in the mature-industry context.

The early pre-project phase is often characterized by a high degree of uncertainty (Floricel et al., 2016). We therefore assume that the goals (e.g., those related to value creation and value capture) of different internal stakeholders have not yet been aligned and that such performing paradoxes (Smith & Lewis, 2011) may lead to intra-organizational tensions in the pre-project phase. However, in the implementation phase, we may assume that conflicting goals between competing firms become visible, which could lead to inter-organizational tensions.

We also assume that learning paradoxes (Smith & Lewis, 2011) would lead to tensions in both the pre-project and project implementation phases. In the pre-project phase, firm's internal stakeholders may have different views on whether it is most valuable to be creative or to hold on to existing business and on whether it is most valuable to protect or share knowledge. These intra-organizational tensions may be particularly strong in mature industries, where core competencies are often a source of competitive advantage (Lei & Slocum, 2005), and where managers are often reluctant to endanger existing business (Strebel, 1987). In the implementation phase, we assume that such learning paradoxes may lead to inter-organizational tensions since different participating companies are likely to balance knowledge protection and sharing differently.

Organizing paradoxes (Smith & Lewis, 2011) are also expected to lead to intra-organizational tensions in the pre-project stage since different internal stakeholders may have divergent views on whether the firm's most valuable resources should be allocated to the coopetitive project. These tensions may be especially relevant in mature industries due to the importance of tacit knowledge in that context (Asheim & Coenen, 2005). In the implementation phase, however, we expect that organizing paradoxes could lead to inter-organizational tensions since participating companies may have different cultures, leadership styles and management control systems, and such factors are particularly important in this phase (Axtell et al., 2000; Christiansen & Varnes, 2009).

Belonging paradoxes (Smith & Lewis, 2011) are not expected to lead to inter-organizational tensions but to intra-organizational tensions, particularly in the implementation phase, due to the competing roles of participants. Since persistence and stamina are important in this phase (Farr et al., 2003), it may be difficult for key individuals to balance their internal tasks and their obligations to the coopetitive projects.

To summarize, we assume (1) that learning, performing and organizing paradoxes will lead to strong intra-organizational tensions in the pre-project phase and strong inter-organizational tensions in the implementation phase and (2) that belonging paradoxes do not lead to tensions in the pre-project phase but do lead to strong intra-organizational tensions in the implementation phase. Previous empirical research has explored these assumptions to a limited extent, and the present study is undertaken with this aim (RQ1) and to explore how the tensions are managed (RQ2).

4 Research Methodology

4.1 Research design and sampling

This study uses a qualitative, interview-based research methodology (Raj, Dwivedi, Sharma, Lopes de Sousa Jabbour, & Rajak, 2020; Zomerdijk & Voss, 2011), which is appropriate when the aim is to understand a complex phenomenon and build a theory (Eisenhardt & Graebner, 2007). The unit of analysis is the project; to enable the selection of projects for theory building, we first consulted two managers in a business cluster in Norway whose members were top-performing world-leading competing companies delivering equipment to the mature oil and maritime industries. The cluster and its member companies had a strategic focus on innovation and collaboration. Consultation with the cluster managers led to the identification of five projects deemed suitable for this study after careful review of publicly available information such as project and company webpages, newspaper articles and evidence of coopetition practices.

The five analysed projects had reached different phases when the first round of data was collected: one was in the pre-project phase, three in the implementation phase, and one was already finalized. The one in the pre-project phase underwent a second round of data collection when it reached the implementation phase . All projects involved two or more competitors. However, in two projects, because of the tensions, one competitor had decided to leave the project in the pre-project phase. The characteristics of the selected projects are presented in Table 1.

Table 1: The sample

Project	Participants	Description and status	Funding	Types of informants	Number of interviews
A	Four competing companies, one university, one research institute and a business cluster. The companies participating in the project had different sizes, and the companies'	The project aimed to develop a new technology. At the time of the investigation, the project had reached its mid-term evaluation. The research and development activities were carried out in several work packages, and the competitors were involved in most of them.	The project was funded by the companies and the Research Council of Norway.	PM, HLM, MLM, CM, RIE, UE	15

	owners came from different countries.				
B	Four competing companies, a few non-competing companies, one business cluster and one university. The participating companies had different ownership and sizes.	The project aimed to develop and implement a new test laboratory. It was already finalized in the time of our investigation.	The establishment of the laboratory was funded by the university, but the laboratory needs to sustain itself based on market principles.	PM, HLM, MLM, CM, RIE	7
C	Two competing companies and several other companies and universities. The participating companies were nationally owned and had similar sizes.	The project aimed to develop a new model for data sharing. The competing companies were separated in two different work packages. The project implementation phase had just begun at the time of the investigation.	The project was funded by the companies and Business Finland.	PM, HLM, MLM	3
D	Two competing companies, two non-competing companies, one university and one research institute. The competing companies had different sizes and ownership.	The project aimed to develop new business models and services. The project was in the pre-project phase at the time of the first round of data collection; due to tensions, one competitor left the project just before our investigation began. Later, another	The project was funded by the companies and the Research Council of Norway.	PM, HLM, CM, UE, RIE	6

		competing company joined the project, and we conducted follow-up interviews to enable analysis of the project implementation phase.			
E	Two competing companies, three non-competing companies, one university, one research institute and one business cluster. Both competing companies were large, but there was a difference in their country of ownership.	The project aimed to develop new business models.	The project was funded by the companies and the Research Council of Norway.	PM, HLM, MLM, CM, RIE	8

Legend: PM: Project manager; HLM: High-level manager (CEO, vice president); MLM: Mid-level manager; CM: Cluster manager; RIE: Research institute employee; UE: University employee.

4.2 Data collection

Data were collected through semi-structured in-depth interviews with the project managers leading each project. A snowballing procedure was used to identify further key informants who 1) were directly involved in the projects, 2) possessed rich information and 3) had a mandate to discuss these sensitive topics. This procedure has proven valuable for reaching informants because their willingness to participate is based on trust (Atkinson & Flint, 2004), which is particularly important in our study due to the sensitive nature of coopetition. Furthermore, snowballing is appropriate when informants belong to elite groups (Atkinson & Flint, 2004) which, in our case, refers to the managers involved in the selected projects.

We conducted a total of 39 in-depth semi-structured interviews with decision-makers from mid- and high-level management, project managers, cluster managers and researchers from research institutions involved in the projects. The different views of diverse individuals involved in the projects allowed us to compare,

contrast and enrich our findings. Follow-up interviews with some of the informants were conducted to clarify and deepen the findings. Data were collected between winter 2018 and spring 2020. A breakdown of interviews by project is provided in Table 1.

Most interviews (29) were conducted face to face, while 10 with informants located in other countries were conducted over Skype. Each interview lasted between 60 and 90 minutes. An interview guide was developed that consisted of open-ended questions organized around a few main themes related to the company's innovation strategy, decision-making process, concrete project details and information about sources of tensions and their management in different project phases. The guide was adapted to the perspectives of research partners, project managers and cluster managers for those interviews. Each question was followed by a list of follow-up questions. All interviews were audio recorded and transcribed verbatim.

4.3 Data analysis

The interview data were analysed following a flexible pattern matching approach, which combines both inductive and deductive logics; it has seen increasing use and is valuable for theory building and extending established theoretical boundaries (Sinkovics, Choksy, Sinkovics, & Mudambi, 2019). It is based on iterative matching between theoretical patterns and empirical observations, where revealed mismatches lead to refinement of initially developed theoretical assumptions (Bouncken & Barwinski, 2021; Bouncken, Qiu, Sinkovics, & Kürsten, 2021; Sinkovics, Sinkovics, & Yamin, 2014). Following this approach, interview data were firstly descriptively summarized and then grouped according to Smith and Lewis's (2011) classification of organizational paradoxes as sources of tensions that appear in the two distinct project phases. In a third step, the identified tensions in each phase were categorized as intra- and inter-organizational tensions (Appendix A). In a fourth step, an iterative comparison between initially developed theoretical assumptions and empirical observations was performed. Particular attention was paid to mismatches and consequent refinement of the assumptions in line with observed sources and types of tensions in the pre-project and project implementation phases. Two authors read the transcriptions separately, discussed the data and performed the analysis together. After that, all three authors jointly discussed the findings. During the analysis, information obtained in the interviews was complemented with archival

data, such as internal project documentation describing its organizational structure, annual progress reports for the projects, documentation regarding the pre-project phase, project-related presentations from individual companies, press releases and publicly available data from companies' and projects' web pages. These pieces of information were used to ensure an appropriate understanding of the different projects' phases, current status and progress achieved, along with a better understanding of the organizational structure and the cultures of the participating companies.

5 Findings

The aim of this study is to extend our knowledge about the sources, types and management of tensions in the pre-project and implementation phases of coopetitive innovation projects in the unique context of mature industries. Following the flexible pattern matching approach, the initially developed theoretical assumptions were compared with empirical data from five coopetitive innovation projects in mature industries. Table 2 summarises the observed sources and types of tensions during the pre-project phase compared to the project implementation phase and reveals certain deviations from our theoretical assumptions. A presentation of more detailed findings for each project phase in terms of both type of tensions and how they were managed, follows.

Table 2: Summary of observed tensions compared with our theoretical assumptions

Smith and Lewis's (2011) classification of paradoxes	**Pre-project phase**		**Project implementation phase**	
	Expected	**Observed**	**Expected**	**Observed phase**
Performing	Strong intra-organizational tensions	Strong intra-organizational tensions	Strong inter-organizational tensions	Strong inter-organizational tensions
Learning	Strong intra-organizational tensions	Strong inter-organizational tensions	Strong inter-organizational tensions	Strong inter-organizational tensions

Organizing	Strong intra-organizational tensions	Strong intra-organizational tensions	Strong intra-organizational tensions	Strong inter-organizational tensions
Belonging	Not expected	Not observed	Strong intra-organizational tensions	Not observed

5.1 The pre-project phase[1]

Initially, we expected strong intra-organizational tensions driven by performing, learning and organizing paradoxes in the pre-project phaseof coopetitive innovation projects in mature industries, with belonging paradoxes expected to be absent. Our empirical data supported these assumptions, except the one related to learning paradoxes.

Our informants confirmed strong intra-organizational tensions due to performing paradoxes rooted in different opinions of internal stakeholders regarding choosing between value creation at the company or project level and the risk aversion evident in managerial behaviour (Quotes 1 and 2). Informants also pointed out strong intra-organizational tensions caused by organizing paradoxes that were rooted in organizational cultures and influenced companies' internal decision-making processes. Companies whose employees indicated more hierarchical and bureaucratic decision-making procedures appeared to be more oriented towards closed than collaborative innovation practices and experienced greater intra-organizational tensions when identifying coopetitive opportunities. Companies whose employees indicated flatter decision-making process were more inclined to collaborate with external actors during innovation processes (Quotes 3 and 4). A few informants reported that a closed internal corporate culture led to a high degree of intra-organizational tensions during the pre-project phase, adding that this culture could be a limitation for people involved in negotiations (Quote 5). Lastly, belonging paradoxes were not identified in our data, as we expected.

Our findings indicated that intra-organizational tensions need to be managed within companies (Quote 6). Only one company had not been able to manage tensions rooted in organizational paradoxes, specifically those related to internal

1 All quotes related to section 5.1 (the pre-project phase) are presented in Table 3.

decision-making processes, and decided to leave the project (Quote 7).

As indicated, one assumption was not confirmed. While we assumed that learning paradoxes would cause strong intra-organizational tensions in the pre-project phase, our data indicated that learning paradoxes, which are rooted in the need to simultaneously share and protect a company's knowledge and core competencies and ownership of the common project results (in the form of intellectual property rights), cause strong inter-organizational tensions in the pre-project phase. Those tensions manifested themselves between competing companies when defining the scope of work, especially if the project management team did not pay enough attention to the scope of work (Quote 8), rules for data sharing and protection (Quote 9) and regulation of the intellectual property rights (Quote 10).

Learning-related inter-organizational tensions were managed by project managers. Our informants reported three ways to successfully manage those tensions in the pre-project phase: 1) clear contractual regulations in a formal consortium agreement established by lawyers through a long, iterative and dialogue-based process (Quote 11); 2) precise rules stipulating that a company's sensitive information can only be shared with project managers, not with competitors (Quote 12); and 3) separation of competing companies within the same project framework (Quote 13).

The exception was Project D, where learning-related inter-organizational tensions could not be overcome. The lead company in project D expressed serious concerns over losing proprietary knowledge due to the involvement of the company's direct competitor, leading to the withdrawal of the competitor from the project (Quote 14). Since the project manager was a high-level manager in the company that caused the tension, no solution could be found, and the competitor had to leave the project.

Table 3: Illustrative quotes: Pre-project phase

Quote no.	Illustrative quote	Type of paradox	Type of tension
1	"I could have two engineers for the cost of the financial involvement [in the project], so I need to eliminate two more people to be able to participate in the project. Then, I need to decide, is it worth	Performing paradox (value creation at project versus firm level)	Intra-organizational tension

	it? Is the outcome of the project for our company better than keeping two more resources in-house? This is the kind of discussion we had internally. One issue is financial, but we need to participate with other resources. The hours we put into the project: is this the best way can use these hours, or could we use them to produce products we could sell?" *HLM, company in Project A*		
2	"Managers get bonuses based on their performance and revenues.… They have some personal incentives … and that can be a barrier because if you want to participate in the project, you have to risk losing something in order to gain something. If they want their bonuses, by continuing as usual, they will be more likely to obtain their bonuses in the short term." *MLM, company in Project E*	Performing paradox (risk-averse managers)	Intra-organizational tension
3	"The strategy for our company is that the decisions are taken by the management at headquarter, which is far from here, so we cannot participate in projects in the same way as our competitor because of the differences in structure and organization." *MLM, company in Project E*	Organizing paradox (decision-making processes and organizational culture)	Intra-organizational tensions
4	"[There was] a difference between a [foreign] and a Norwegian organization and mentality. We are flatter in organization, operate more informally and communicate easily. They are more hierarchical." *MLM, company in Project E*	Organizing paradox (organizational culture)	Intra-organizational tensions

5	"The company doesn't have an internal culture for interaction with universities or collaboration at all.… Coopetition, that is like ... it is like you are … leaking knowledge or you are doing something that's not allowed … Really, tension, in the beginning, is internal." *MLM, company in Project A*	Organizing paradox (organizational culture)	Intra-organizational tensions
6	"Decisions were made in stages; in the beginning, it was only ... this was only taken care of by the global director in Norway. He was the one I was talking to; I guess he was trying to sell it to his people. He sold it, and I think he saw that this is the right thing to do. But it took him a year or more to get the support internally that we should do this. It was a lot of selling, internal meetings, participating in project conferences.... And slowly we caught the attention of middle management, and they found it interesting." *MLM, company in Project A*	Organizing paradoxes (decision-making processes successfully managed)	Successful management of intra-organizational tensions caused by organizing paradoxes
7	"I think it was kind of strange that we were involved in that.… I'm not sure if the management in Norway was too much involved." *MLM, company in Project E*	Organizing paradoxes (decision-making processes unsuccessfully managed)	Unsuccessful management of intra-organizational tensions caused by organizing paradoxes
8	"People could have spent less time on unimportant issues and focused more on the scope of work, getting a very detailed scope of work … because then the initial tension would have been lower." *MLM, company in Project A*	Learning paradoxes (scope of work)	Inter-organizational tensions
9	"We want to have control of it. We want to be able to steer it, so our background information was not necessarily shared with the rest,	Learning paradoxes (data sharing versus protection)	Inter-organizational tensions

	because then we don't have control of the information." *HLM, company in Project E*		
10	"I put my money on the table in this project and the competitor says, 'I don't want to put any money on the table,' but then, two, three years down the road, the project is about to file an IPR that could be very useful for the competitor. The competitor decides to enter the system, but it has not put any effort into making that IPR happen." *HLM, company in Project A*	Learning paradoxes (intellectual property rights protection)	Inter-organizational tensions
11	"I had the best lawyer on my side: a very old and experienced lawyer, who has written international contract agreements, who was a good mediator between different companies and their lawyers." *Project manager in Project A*	Learning paradoxes (management)	Successful management of inter-organizational tensions caused by learning paradoxes
12	"The research contributions are shared, of course, and that's the nature of the game, but company-specific information is, of course, something that is regulated." *HLM, company in Project C*	Learning paradoxes (data sharing versus protection: clear regulation of sharing sensitive information)	Successful management of inter-organizational tensions caused by learning paradoxes
13.	"That was a decision we all wanted: competing companies did not want to be in the same work package but in the same overall framework." *Project manager in Project C*	Learning paradoxes (data sharing versus protection-separation principle)	Successful management of inter-organizational tensions caused by learning paradoxes
14	"The main issue is how we share information and what information can be shared between the partners.… When it goes to the researchers, it doesn't have to go to all the participants.… We would like to learn from other companies	Learning paradoxes (data sharing versus protection)	Unsuccessful management of inter-organizational tensions caused by learning paradoxes

that are not directly competing
with us."

Project manager in Project D and HLM at a competing company

5.2 The project implementation phase[2]

In the project implementation phase, we expected strong inter-organizational tensions driven by performing, learning and organizing paradoxes and strong intra-organizational tensions driven by belonging paradoxes. Our empirical data supported these assumptions, except those related to belonging paradoxes.

Our informants revealed that performing paradoxes arose due to the different strategies and goals of competing companies and caused strong inter-organizational tensions related to contributions. More precisely, in the implementation phase we found that companies could decide to limit their contributions and focus on obtaining knowledge from others (Quote 15). This type of tension needs to be managed at the project level. Our findings suggest that tensions related to limited monetary contributions were managed by formal mechanisms, while tensions related to contributions of working hours were first addressed less formally through discussion with the companies. If that did not prove an effective tool to resolve them, then formal mechanisms were introduced (Quote 16).

The informants also indicated learning paradoxes as a source of data sharing versus data protection inter-organizational tensions, since companies want to learn from others while overprotecting their own information, due to high levels of complementarity and similarity between competitors that increase companies' perceived vulnerability (Quotes 17, 18 and 19). Project managers were responsible for resolving tensions related to data sharing and protection. During the project implementation phase, they addressed tensions by adopting different procedures, both formal and informal, for data sharing with different companies (Quote 20). Surprisingly, some informants also indicated that, apart from the project level,

2 All quotes related to section 5.2 (the project implementation phase) are presented in Table 4.

solving this type of tension happens partly at the company level, when companies learn which type of information they can share with competitors (Quote 21).

Lastly, our data indicated the presence of inter-organizational tensions due to organizing paradoxes, with certain companies requiring changes in the organization of collaboration during the implementation phase (Quote 22). These tensions were successfully addressed by project managers through the establishment of separate meetings between researchers and project managers and competing companies (Quote 23 and 24). Contrary to what we expected, we did not find evidence that belonging paradoxes caused any tensions in the implementation phase.

Table 4: Illustrative quotes: Project implementation phase

Quote no.	**Illustrative quote**	**Type of paradox**	**Type of tension**
15	"Companies can obtain information without contributing, or smaller companies that put in less money or fewer hours or whatever can also obtain benefits. It might be that those companies get more out of this project than we do. We put in a lot of effort, money and hours." *MLM, company in Project A*	Performing paradox (contribution)	Inter-organizational tension
16.	"It's informal to start with. We give them a chance. But now in December, they will have the in-kind reports, and we will see. If it's a second warning, then we have to make it more formal.… With the cash, it's quite easy, because we send them an invoice, but in-kind is more difficult. But let's say they don't deliver enough, and their obligation is just shifted to the next years. So, they get more and more and more commitment. And then at some stage, we see, 'this is not realistic, you're just pushing the problem in front of you.' So then, we have to decide if we take them out of the	Performing paradox (managing contribution)	Successful management of inter-organizational tensions caused by performing paradox

	project. Because it's not fair if you get all the results, and then at the end, 2021, you have 1000 hours of in-kind not delivered. That should not happen." *Project Manager in Project A*		
17.	"What drives a company is fear: the fear of missing out on knowledge, the fear of losing extra value compared to competitors." *HLM, Project C*	Learning paradox (data sharing versus protection)	Inter-organizational tension
18	"We are both in the same industry. We are quite advanced companies, so even just a small hint of something could actually trigger thoughts on the other side already." *HLM, company in Project B*	Learning paradox (data sharing versus protection)	Inter-organizational tension
19	"Being in a competitive environment, it's not that easy to talk about your knowledge and problems because you are afraid that it makes you vulnerable." *MLM, company in Project E*	Learning paradox (data sharing versus protection)	Inter-organizational tension caused by learning paradox
20.	"We don't have formal agreements with all the companies. Some are local. Some are here but have owners in [a foreign country]. So the procedures are different. We take that data from a Norwegian company. It's more trust-based: we can use zip files and do the manual work ourselves, and the bureaucracy is lessened.… But when we try to take the data from a [foreign]-owned company, then the process is a bit more bureaucratic, and they certainly have to go back to headquarters and ask for approval. And these kinds of processes take a much longer time."	Learning paradox (solution for data sharing and protection: different procedures for different companies)	Successful management of learning caused inter-organizational tensions at project level

	Work package manager in Project A		
21.	"To start with, we didn't really know how this would work out and we were holding back more. Now, we see that it's possible to do both things: to support the projects as they are defined but also keep what we want to keep for ourselves." *MLM, company in Project A*	Learning paradox (solution at firm level)	Successful management of learning caused inter-organizational tensions at firm level
22.	"The idea in the beginning was to have one research group working with all companies. But, one company said that they cannot collaborate with the other because they are too strong competitors. So they asked us to find a new model where there's no information going between the research group working with each of those two competing companies." *Project manager in Project D*	Organizing paradox (requirement for changes in project organizational structure)	Inter-organizational tension caused by organizing paradox
23.	"And now you have two groups of researchers working with those two companies in the same project." *Project manager in Project D*	Organizing paradox (managed through separate meetings)	Successful management of inter-organizational tensions caused by organizing paradox
24	"Separate meetings with them to discuss what they want, what they like, what they have seen from the project, how happy they are, what they need to do, what the interest is for the project.... They are competitors and to talk more freely you need one to one." Project manager in Project A	Organizing paradox (managed through separate meetings)	Successful management of inter-organizational tensions caused by organizing paradox

6 Discussion

While scholars distinguish between intra- and inter-organizational tensions (e.g., Raza-Ullah et al., 2014; Tidström, 2014), we use paradox theory (Smith & Lewis, 2011) as a lens to reveal the underlying factors of inter- and intra-organizational tensions in the context of mature industries. We also reveal how inter- and intra-organizational tensions were associated with different project phases and how their management affected collaborative relationships. A discussion of the findings follows.

6.1 Type of tensions and their management in the pre-project phase

Following the paradox perspective, coopetition scholars have discussed intra-organizational tensions as a result of the spillover of inter-organizational tensions into companies and managerial capabilities to assess and communicate the benefits of coopetitive collaborations (Bengtsson et al., 2016b; Eisenhardt et al., 2010; Raza-Ullah et al., 2014). Our findings extend those debates by revealing performing and organizing paradoxes as factors causing strong intra-organizational tensions in the pre-project phase. Similarly to previous studies (e.g., Raza-Ullah, 2020), performing paradoxes appeared to be rooted in managerial mindsets and capacities to assess the benefits and risks of this type of collaboration.

As opposed to coopetition research in emerging industries that has identified organizational culture as a key factor causing inter-organizational tensions (Fernandez et al., 2014; Tidström, 2009; Zeng, 2003), we identified it as a context-specific source of organizational paradoxes and intra-organizational tensions in the pre-project phase in mature industries. This finding can be discussed in relation to the competing values framework (Quinn & Rohrbaugh, 1983) and Büschgens, Bausch, and Balkin's (2013) explanation of organizational culture as a coordination tool that fosters or undermines innovation processes. In line with Büschgens et al. (2013), our data indicated that companies with hierarchical, internally oriented organizational cultures were more focused on preserving internally stable processes and experienced stronger organizational paradoxes and consequently stronger intra-organizational tensions in the pre-project phase. Companies with a more rational, externally oriented organizational culture were, on the contrary, more able to embrace information and innovation opportunities from outside the firm. This contradicts Klimas's (2016) findings that companies with a hierarchical organizational structure are typically more eager to engage in

coopetition, because formalization, standardization and strict norms mitigate coopetitive risks and negative consequences within a company. Klimas (2016) did not recognize corporate culture as an obstacle for coopetitive collaboration, but in our sample, it was especially apparent with companies whose headquarters were in a different country and were more oriented towards firm-centric innovation practices. Accordingly, our findings allow us to formulate the following propositions:

P1a: Performing and organizing paradoxes are the dominant sources of intra-organizational tensions that companies in mature industries experience in the pre-project phase of coopetitive innovation projects.

P1b: In the pre-project phase of coopetitive innovation projects in mature industries, companies with a hierarchical, internally oriented organizational culture experience greater organizing paradoxes and intra-organizational tensions than companies with a rational, externally oriented organizational culture.

We found that performing paradoxes were managed through managerial assessment of the project relevance and decisions to allocate resources to coopetitive projects. This echoes previous research on the relevance of managerial perceptions and coopetition capability to hold intra-organizational tensions to a moderate level while embracing both coopetition and cooperation (Bengtsson et al., 2016b; Raza Ullah, 2017). Furthermore, while the coopetition literature has mainly discussed resource allocation at the collaborative level (Tidström et al., 2018), we have shown its crucial importance at the firm level in the context of mature industries. Our data suggest that resource allocation was the responsibility of senior managers, based on the top-down processes described by Hutchison-Krupat and Kavadias (2015). Those processes have not proven to be particularly effective in emerging high-tech environments (Schlapp, Oraiopoulos, & Mak , 2015) but may be more important in the context of mature industries (Tidström & Rajala, 2016). In a difference from Bengtsson et al., (2016b) and Lundgren-Henriksson and Kock (2016), who reported middle managers' potential responsibility for sabotaging a coopetition strategy, we identified top managers in charge of defining the strategy and terminating its implementation, even if middle managers saw value in it.

When explaining the management of intra-organizational tensions caused by organizing paradoxes, it is important to note that the lower levels of intra-organizational tensions in coopetitive innovation projects have been found in

emerging industries (e.g., Fernandez et al., 2014) compared to our findings in the context of mature industries. This might be related to higher levels of collaborative orientations of companies in emerging industries (Chesbrough & Crowther, 2006) compared to mature industries (Bodas Freitas et al., 2013; Tidström & Rajala, 2016). As Lundgren-Henriksson and Kock (2016) and Vanyushyn et al. (2018) indicated, issues in the implementation of a coopetition strategy may be rooted in its incompatibility with internal companies' routines and practices, as also revealed in our study.

Against this backdrop, we propose that intra-organizational tensions may be handled at the company-level using a so-called "working through" strategy (Smith & Lewis, 2011), which suggests the acceptance of inevitable tensions rather than defensiveness to empower managers to engage in paradoxical thinking and sensemaking. To apply this strategy, managers need certain cognitive, behavioural and emotional characteristics, and companies need dynamic capabilities (Smith & Lewis, 2011). Accordingly, we offer a second proposition:

P2: Intra-organizational tensions in the pre-project phase of coopetitive innovation projects in mature industries can be handled by using a working-through strategy at the company level.

As knowledge and technology represent the main sources of competitive advantage in mature industries (Tidström & Rajala, 2016), we expected strong intra-organizational learning tensions in the pre-project phase in this context. However, learning paradoxes caused only inter-organizational tensions, as has been found in other contexts (Fredrich et al., 2019; Gast et al., 2019; Tidström et al., 2018). The companies were, like the findings in other studies, deeply concerned about "project-specific versus company-specific" data sharing due to perceived competitors' learning and absorptive capacity, risks of knowledge leaks and intellectual property rights over the project results (Fernandez & Chiambaretto, 2016; Fredrich et al., 2019; Ritala & Tidström, 2014). As Klimas (2016) indicated, companies preferred independence over collaboration with a strong focus on value protection and appropriation mechanisms.

Strategies applied to manage inter-organizational tensions caused by learning paradoxes in the pre-project phase of our projects may be associated with an iterative combination of Smith and Lewis's (2011) working-through strategy, which is suitable for reaching formal solutions to protect intellectual property, and iterating splitting and integrating to establish specific rules for sharing sensitive

information and separating competing companies when needed. Our data indicated that both strategies are needed for successful management of tensions since a failure to employ the second approach resulted in one company withdrawing from a project. While Rouyre and Fernandez (2019) claimed the crucial importance of formal knowledge protection mechanisms in coupled coopetitive projects, our findings align more closely with Tidström et al.'s (2018) suggestion for mutual use of interactional and procedural practices. Our findings also accord with the importance of proactive efforts in early project phases reported in the project management literature (Jalali Sohi et al., 2019; Nguyen et al., 2018; Nobelius & Trygg, 2002) based on both flexibility and control (Kock et al. 2016; Koppenjan et al. 2011) and further confirm that unresolved tensions in the pre-project phase lead to failures, as highlighted in previous studies (e.g. Floricel et al., 2016). Thus, we offer the following propositions:

P3a: Learning paradoxes are the dominant sources of inter-organizational tensions that companies in mature industries experience in the pre-project phase of coopetitive innovation projects.

P3b: In the pre-project phase of coopetitive innovation projects in mature industries, successful reduction of inter-organizational tensions caused by learning paradoxes requires an iterative combination of splitting-and-integration and working-through strategies.

6.2 Types of tensions and their management in the project implementation phase

While performing and organizing paradoxes appeared at the company level and caused strong intra-organizational tensions in the pre-project phase, we found that the same paradoxes – together with the learning paradox – raised inter-organizational tensions in the project implementation phase. In line with Smith and Lewis (2011), coopetitive innovation projects can therefore be understood as a dynamic environment with "persistent opposing forces that require constant adaptation and purposeful solutions" (p. 387) in each of the project phases. In line with Dahl's (2014) arguments, performing, organizing and learning paradoxes in the project implementation phase were influenced by changes in the cooperative and competitive interactions between the two project phases and the shift between cooperative and competitive attitudes among the partners (Ritala & Tidström, 2014). They caused strong inter-organizational tensions, as indicated in the

following proposition:

P4: Inter-organizational tensions rooted in performing, organizing and learning paradoxes are the dominant types of tensions that companies in mature industries experience in the project implementation phase of coopetitive innovation projects.

Performing paradoxes, manifested as intentions to benefit from a project while limiting a firm's own contributions, resonate with the opportunistic behaviour identified in previous studies (Osarenkhoe, 2010) and were solved by project managers using a working-through strategy. Unlike scholars who have discussed the best ways to organize coopetitive collaborations through integration, separation or co-working principles (Le Roy & Fernandez, 2015), our findings revealed the need to alternate between different organizational modes during project phases to accommodate the coopetitive dynamics we observed. For instance, organizing paradoxes in the implementation phase were successfully managed by a separation that corresponds to a splitting-and-integration strategy, while learning paradoxes required a combination of a splitting-and-integration – by using different mechanisms for different companies – strategy at the project level and a working-through strategy that involved learning what to share at the company level. The last solution reveals the interconnectedness between specific management styles for handling particular information tensions at the project level (Fernandez & Chiambaretto, 2016; Tidström et al., 2018) and learning processes at the company level (Dahl, 2014; Gast et al., 2019). This also confirmed that relying on solely formal or informal knowledge-sharing practices will not suffice to successfully resolve learning tensions in the project implementation phase (Fernandez et al., 2014; Rouyre & Fernandez, 2019). Furthermore, apart from the attention to coopetitive managerial capabilities within companies (Bengtsson et al., 2016b; Raza-Ullah, 2020; Raza-Ullah et al., 2014), our findings show the importance of project managers' abilities to observe, understand, communicate and react to observed paradoxes in a timely fashion to successfully solve inter-organizational tensions in the implementation phase. Lastly, the absence of the belonging paradoxes we expected in the implementation phase may be explained by the organization of all the projects in our sample. Even though they were members of integrated project teams, company employees remained housed at their own firms and only participated in common project meetings that did not lead to internally conflicting tasks or tensions. Based on this finding, we offer our final propositions:

P5a: A working-through strategy reduces the inter-organizational tensions rooted in performing paradoxes in the implementation phase of coopetitive innovation projects in mature industries.

P5b: A splitting-and-integration strategy reduces inter-organizational tensions rooted in organizing paradoxes in the implementation phase of coopetitive innovation projects in mature industries.

P5c: A combination of splitting-and-integration and working-through strategies reduces tensions rooted in learning paradoxes in the implementation phase of coopetitive innovation projects in mature industries.

The discussion and consequent propositions are summarized in Table 5.

Table 5: Summary of Propositions

Organizational Paradox	**Pre-project phase**		**Project implementation phase**	
	Type of tension	**Management**	**Type of tension**	**Management**
Performing	Intra-organizational (P1a)	Working through at company level (P2)	Inter-organizational (P4)	Working through at project level contribution (P5a)
Organizing	Intra-organizational (P1a, P1b)	Working through at company level (P2)	Inter-organizational (P4)	Separation principle at project level (P5b)
Learning	Inter-organizational (P3a)	Separation and integration (for data sharing) combined with working through (for intellectual property) at the project level (P3b)	Inter-organizational (P4)	Separation and working through mix at project level Working through at firm level (P5c)

6.3 Implications for research and practice

This study contributes to the coopetition literature in several ways: first, it enriches the understanding of the coopetition paradox by revealing how

organizational paradoxes (Smith & Lewis, 2011) influence coopetitive tensions and the strategies that can be used to successfully address them. The mainstream coopetition literature (e.g., Fernandez et al., 2018) regards the success of coopetitive innovation projects as dependent on the appropriate management of tensions; thus, enhancing our understanding of these is of critical importance for the development of both coopetition theory and practice. Second, our findings revealed that tensions at the project and company level overlapped, so this paper contributes to academic debates about intra-organizational versus inter-organizational tensions (e.g., Bengtsson et al., 2016b). We distinguish between project phases in which one or the other type is prevalent. Third, our focus on different project phases provides insights into the influence of actions that participants undertake during collaboration and thus contributes to knowledge about coopetitive dynamics (Dahl, 2014; Pattinson, Nicholson, & Lindgreen, 2018) as operationalized though concrete mechanisms and tensions and their management. Fourth, our findings indicated that some peculiarities, such as strong organizational paradoxes that caused significant intra-organizational tensions in the pre-project phase may be attributed to mature industries and represent context-specific insights (Czakon & Rogalski, 2014; Jakobsen, 2020). Furthermore, the study answers scholarly calls for more insights from the project perspective (Bengtsson, Kock, Lundgren-Henriksson, & Näsholm, 2016a) while also revealing that the interrelations between the project and company levels cannot be ignored. In addition, we contribute to the project management literature by offering new insights into the pre-project phase. Lastly, we have developed a set of propositions that can guide future empirical studies.

The study findings can inform project managers, companies and other relevant parties, such as research institutions and business clusters, that aim to join forces with competing companies in innovation projects by helping them benefit from this type of collaboration. The findings suggest that companies in mature industries may expect strong intra-organizational tensions rooted in organizational and performing paradoxes in the pre-project phase. In the project implementation phase, critical attention needs to be paid to inter-organizational tensions rooted in performing, learning and organizing paradoxes at the project level. Our findings also suggest that firms' top-level management is responsible for managing intra-organizational tensions, whereas project managers are in charge of inter-organizational tensions. Furthermore, there is no single way to manage an entire

project; the findings suggest that employing a working-through strategy to manage intra-organizational tensions in the pre-project phase and an iteration between working through and splitting and integration to manage inter-organizational tensions in the implementation phase will increase the chances that competing companies will remain in a project and achieve desirable results.

6.4 Limitations and future research

No research is without limitations. We have explored the unique context of mature industries and acknowledge that a comparative study of mature and emerging industries might provide more in-depth insights. Most of our sampled projects had not reached finalisation which is another aspect that might be addressed in future studies. We also acknowledge that the presence of universities in the sampled projects may impact the relationships between competing companies and calls for future research with particular attention to the role of non-competitive partners like universities and research organizations. Most projects in our sample were at least partly funded by the government and had similar degrees of newness. An interesting perspective for future research could be to explore whether and how government funding influences the dynamics of coopetition and relations between competing companies in coopetitive innovation projects. It may also be interesting to explore whether the tensions that arise in radical projects – and their management– differ from those in more incremental projects.

Future research could also adopt a longitudinal view. For instance, while our findings indicate that activities at the company level do affect project-level activities and vice versa, longitudinal research could examine this relationship in more depth. From a theoretical standpoint, this study used paradox theory as a lens to understand the underlying factors of coopetitive tensions. However, some of our findings could also be interpreted by transaction cost theory or contingency theory or through a combination of the dynamic relational view, knowledge perspective and coopetitive tensions. While our focus was at the project and firm levels, future studies could examine the socio-emotional and cognitive tensions at the individual level . Lastly, future studies could empirically test the propositions we have derived.

7 Conclusion

This study applied the paradox lens to explore tensions and their management in different project phases of coopetitive innovation projects in mature industries.

Its main distinction from the previous literature lies in its revealing important differences in the types and management of tensions that occur in the pre-project and project implementation phases of such initiatives. Furthermore, we shed light on their influence on the continued participation of competing companies in those projects.

The findings indicated that performing and organizing paradoxes caused by specific innovation strategies and cultures of companies in mature industries raise strong intra-organizational tensions during the pre-project phase. These tensions may harm companies' participation in coopetitive projects and need to be accepted and worked through internally, based on the proper allocation of resources between internal and external projects and the adaptation of organizational routines and procedures. On the contrary, organizing, performing and learning paradoxes raise strong inter-organizational tensions between competing companies in the project implementation phase and need to be addressed by iterated working-through and splitting-and-integration strategies. Therefore, the success of the pre-project phase depends on companies' abilities to manage intra-organizational tensions, while project managers' abilities to stay abreast of coopetitive dynamics, address company specific-requirements and craft proactive responses become critical in the project implementation phase.

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Appendix A: An example of the coding of sources of tensions in the pre-project phase

The 1st step in coding:	**The 2nd step in coding:**	
Descriptive codes about the sources of tensions	Categories according to Smith and Lewis's (2011) classification of organizational paradoxes	**Theme that emerged**
Risk-averse managers		
Managers rely on rewards		
The most effective way to use resources	Performing paradoxes	
Resources allocated to internal innovation		
Resources allocated to collaborative innovation		Intra-organizational tensions
U.S. ownership and top management		
Norwegian ownership and top management		
Open Norwegian organizational culture		
Closed U.S. organizational culture		
The idea is a dangerous thing	Organizing paradoxes	
Buy research; don't collaborate		
Top-down decision-making process		
The boreoarctic long-lasting decision-making process		
Decisions made by headquarters		

Many hierarchical levels inside the company		
Close to core knowledge		
Changing competitive edge		
Who has the right to patent?		
When can companies patent?		
How can patents be shared?	Learning paradoxes	
Control over background information		Inter-organizational tensions
Which data can be shared?		
Rules for selective data sharing		
Rules for data protection		

Paper 3

Beyond the Dyad: Role of Non-Competitive Partners in Coopetitive R&D Projects

Sanja Smiljic

Abstract

R&D projects between multiple partners have been examined by various disciplines at the macro-, micro- and meso-level. Even though scholars have acknowledged the possibility that both competitive and non-competitive partners participate in such projects, we still lack a holistic perspective on their complex interactions. This paper builds on open innovation and coopetition literature to explore the influence of research partners and clusters on the relationships between competing companies in different project phases of R&D projects. The study is based on insights from five coopetitive R&D projects in mature industries. Findings revealed the need for simultaneous involvement of research partners and clusters when establishing the collaboration in the pre-project phase, while research partners have dominant roles in balancing coopetition in both the pre-project and project implementation phases. Propositions are offered to inform future studies and managerial implications are discussed.

Keywords: Coopetition; R&D Projects; University–Industry Collaboration, Role of Research Partners; Role of Clusters; Mature Industries

1 Introduction

R&D collaboration with multiple partners is of interest for several research disciplines, including economics, economic geography, organisation studies, strategy and management (Corsaro, Cantù and Tunisini, 2012). Scholars have examined collaborative actors, their characteristics and interactions, the management of their relationships and possible outcomes at the macro-, meso- or micro-level (Corsaro, Cantù and Tunisini, 2012; Ritala *et al.*, 2017). While previous studies have revealed appreciable insights regarding multiple-partners interactions, competitive and non-competitive partnerships have been often analysed separately.

Collaboration between competing companies for innovation is receiving increasing research interest in open innovation (OI; Mention, 2011) and coopetition research streams (Tidström, Ritala and Lainema, 2018). The OI stream has thoroughly examined R&D collaborative practices from the perspective of participating firms, alliances or innovation networks, with scholars seeking further insights on OI projects (Bogers et al., 2017). Meanwhile, the coopetition literature has been mainly focused on the coopetitive dyad and scholars have, to a limited degree, evaluated the effects that other partners may have on the focal coopetitive relationship. Tidström (2014) acknowledged this gap and called for more research about tensions related to actors outside of main coopetitive relationship. To date, this aspect has not received sufficient research attention. Czakon and Czernek (2016), for instance, revealed, in one of limited number of studies, the importance of third-party legitimisation and reputation when competing companies in the tourist sector decide to enter into network coopetition.

To explore how non-competitive partners might influence competitor-to-competitor relationships, this qualitative study focuses on five R&D projects in mature industries that involve competing companies, research partners (RPs; universities and research centres), business clusters and at least one other partner: customer or supplier. The presence of RPs and business clusters as non-competitive partners, in all sampled projects, enables the merging of coopetitive and OI perspectives. New insights beneficial to both streams will be discovered by answering the following research question: How do RPs and clusters influence relationships between competing companies in the pre-project and the project implementation phases of coopetitive R&D projects in mature industries?

Most of the attention in OI and coopetition research streams so far has been drawn to the context of high-tech emergent industries (Pellegrin-Boucher, Le Roy and Gurău', 2018). Examinations of emergent industries, as early adopters of OI practices, have enriched our knowledge about various types of those practices. However, scholars have acknowledged differences in innovation processes and practices as well as collaborations between companies in emergent compared to those in mature phases of the industry lifecycle (McGahan and Silverman, 2001; Bodas Freitas, Argou Marques and de Paula Silva, 2013). Following on that, the context of mature industries in this study should provide new and valuable insights.

The paper is structured in the following manner: Literature is reviewed in Section 2, while Section 3 explains the research method. The empirical results are presented in Section 4. Section 5 discusses the results and concludes.

2 Literature review

2.1 R&D projects

R&D collaboration with external partners, as a form of OI practices, aims for knowledge transfer, integration and new knowledge creation (Chesbrough and Bogers, 2014). While technology sourcing meets current needs, R&D collaboration addresses future needs (Cassiman, Di Guardo and Valentini, 2010). This type of collaboration can be established in the form of networks, alliances or projects. While previous OI research explored the first two forms extensively, less is known about collaborative projects (Bogers et al., 2017). As defined by Du, Leten and Vanhaverbeke (2014), 'R&D projects can be considered as temporary entities that conduct a series of complex and interrelated activities with predefined goals' (p. 829). Exploring short-term, goal-oriented collaboration between loosely connected partners in projects (Culpan, 2014) can produce new and valuable insights about R&D collaborative practices.

2.2 Research–industry R&D collaboration

Scholars associate different partners with different level of risk and different type of co-created knowledge in R&D projects (Hamadi, Leker and Meerholz, 2018). RPs are recognised as valuable sources of knowledge and resources that, under reduced costs and risks, may enhance firms' technological competitiveness, and innovation performance (Belderbos, Gilsing and Suzuki, 2016). Collaboration with RPs results in broader scientific knowledge (Tether, 2002), and may even support moving towards open innovation practices (Guan and Zhao, 2013).

Several researchers have argued that public research can hold different importance for different industries. Cohen, Nelson, and Walsh (2002) claimed crucial importance of university research for a mature manufacturing sector in two aspects: as a source of project ideas and as a source of knowledge for project completion. Established contact networks in mature industries encourage frequent collaboration with university partners, allowing for the integration of new and old technologies as well as problem solving, while emergent industries typically

collaborate with universities for new knowledge development (Bodas Freitas, Marques, and de Paula Silva, 2013). Similarly, Perkmann and Walsh (2007) indicated that the orientation of some industrial sectors towards incremental versus radical improvements had influenced the level, types and mechanisms of research–industry collaboration deployed. More breakthrough-oriented industries use both research partnerships and services to generate cutting-edge output, while industries aiming for incremental improvement, rely more on contract research and paid consulting for a specific industrial client.

Collaboration between the public and private sectors implies alignments of different norms, policies and strategies (Ankrah *et al.*, 2013; Al-Tabbaa and Ankrah, 2016). On the one hand, scientists aim for knowledge creation that can be shared and acknowledged among the scientific community; on the other hand, companies aim for secrecy and appropriation of created knowledge for private gain (Bruneel, D'Este and Salter, 2010; Alexander *et al*., 2020). Following that, relational drivers (such as trust, commitment, effective communication and flexible project management) are highly ranked as factors that support industry and research partners satisfaction in R&D collaborations (Barnes, Pashby and Gibbons, 2002). Regular, timely and accurate communication empowers the development of trust between dissimilar and institutionally different research and industry partners (Bstieler, Hemmert and Barczak, 2017; Rybnicek and Königsgruber, 2019). Communication and coordination are also deemed of particular importance for knowledge sharing and innovation outcomes (Olander *et al.*, 2010) of multi-partner R&D projects (Hamadi, Leker and Meerholz, 2018) which may involve several industry partners, universities and public research organisations (Bogers, 2011).

The increasing complexity of research–industry collaboration and its arising management challenges have brought into the focus the dynamics and changeable nature of collaboration. However, no consensus has been reached regarding success factors for collaboration lifecycle phases. When it comes to relational factors, Plewa *et al*. (2013) found that communication affects collaborative success during all phases (Boehm and Hogan, 2013) and that trust plays a particularly important role in the initiation phase while understanding between partners becomes more important in later phases. Ruangpermpool, Igel, and Siengthai (2020) argued that informal communication combined with formal governance mechanisms may support trust development during the initiation phase of R&D

alliances. This leads to commercialisation phases characterised by higher levels of trust with lower need for coordination and control. That being said, according to Estrada *et al*. (2016), inter-partner dissimilarities do not necessarily hamper collaboration in the start-up phase of research–industry alliances, while lack of goals and expectations alignment may putt desirable outcomes at risk during the post-formation stage. Al-Tabbaa and Ankrah (2016) followed the same vein, emphasising the importance of ties and connections between partners for mitigating the obstacles during the post-formation stage. Ongoing debates and various opinions therefore indicate the need for further research of collaboration lifecycle phases.

R&D collaboration has also been examined from a Triple Helix model perspective (Leydesdorff and Etzkowitz, 1998). Such articles focus on interactions between research institutions, industry and government aiming to ensure certain innovation output and improve regional and national innovation systems (Jiao *et al.*, 2016) by way of selected policies and instruments (Lee and Kim, 2016). The Triple Helix model highlights the importance of universities and other R&D institutions for enhancing innovation (Gaofeng, 2019). This research stream examines policies and measures that support research–industry collaboration and research institutions engagements in innovation development (Faria, Mixon and Upadhyaya, 2019).

While acknowledging highly relevant research–industry collaboration for both policy makers and company innovation strategies (Estrada *et al.*, 2016) scholars have also agreed that there is no single best way to manage increasingly complex research–industry interactions (Mascarenhas, Ferreira and Marques, 2018). To unpack those relationships, scholars have sought insights about day-to-day management of collaborative relations in varying contexts and different phases of collaborative projects (Plewa *et al.*, 2013; Rybnicek and Königsgruber, 2019; Alexander *et al.*, 2020).

2.3 R&D collaboration in clusters

Universities are recognised as important source of knowledge in clusters (Østergaard, 2009; Nishimura and Okamuro, 2011). Cluster literature indicates that knowledge and information flow better in R&D collaboration within the cluster than in such collaboration across cluster borders (Østergaard, 2009). Companies in clusters have more information about their potential partners and

may be approached more for collaboration, leading to higher numbers of collaborative R&D projects (Broekel, Fornahl and Morrison, 2015). However, some scholars (e.g., Nishimura and Okamuro,2011) have indicated that while collaboration with RPs within a region leads to higher R&D productivity, collaboration with industrial partners within a region lowers productivity. Thus, to overcome cognitive lock-ins and over-embeddedness in a cluster, companies may need to complement cluster collaboration with cross-regional collaboration (Molina-Morales and Expósito-Langa, 2012).

Scholars also identified that companies within a cluster may be reluctant to share firm-specific knowledge, and yet be more willing to share general insights (Huber 2012). When geographical proximity between collaborative partners is low, knowledge diffusion may be influenced by various factors, for instance institutional, cognitive or social distance between partners (Molina-Morales and Expósito-Langa, 2012), trust as well as interaction between various partners and stakeholders (Huber, 2012). Therefore, knowledge sharing and R&D collaboration in clusters requires particular guidance and facilitation (Connell and Voola, 2013).

2.4 Coopetition in collaborative relationships

R&D collaboration may involve both competitive and non-competitive partners (Chen, Dai and Li, 2019), allowing for the exploration of coopetition, which was defined by Bengtsson and Kock (2000) as simultaneous cooperation and competition between competitors. Coopetition is recognised as one of the main destabilisation factors affecting trust, harmony and coordination in R&D innovation networks (Ritala and Hurmelinna-Laukkanen, 2009; Rampersad, Quester and Troshani, 2010). Scholars agree that involving competitors in R&D collaborations brings a higher risk of knowledge leaks and opportunistic behaviour (Perks and Jeffery, 2006), can cause information tensions and requires development of specific knowledge sharing and integration mechanisms (Ritala *et al.*, 2017; Yang *et al.*, 2020). Enberg (2012) suggested that, in such settings, problem solving needs to remain an individual activity for each partner, while decision making has to remain a collective action.

When exploring R&D collaboration, scholars were mainly focused on management and orchestration, partner positioning and power, or tensions related to knowledge sharing or integration (Ritala et al., 2017). Few studies went further to explore interactions between competitive and non-competitive partners. Czakon

and Czernek (2016) identified that reputation and legitimisation of the third party are crucially important for competing companies in touristic sector to determine if they would enter network coopetition. Chen, Dai and Li (2019), for instance, notified that involvement of market competitors together with other partners (e.g., suppliers, universities and customers) forms curvilinear relationships with interactions in consortia and U-shaped relationships with joint R&D results. To the best of author's knowledge, beyond that, complex interactions between competitive and non-competitive partners in R&D collaboration haven't received much attention.

Regarding collaboration in clusters, scholars have claimed that close geographical concentrations of competing companies within a cluster reduces the possibility of technology and information monopolisation and may lead to stronger competition (Chung and Cheng, 2019). As clusters mature, companies within them become more conscious of opportunistic risks. To protect competitive advantage, they tend to collaborate mainly in the areas which don't affect their competitive edge, such as for instance cost reduction (Felzensztein, Gimmon and Deans, 2018). Balancing between competition and collaboration has found to be particularly important in tourism clusters, due to high interdependence and complementarity of companies in this sector (Chim-Miki and Batista-Canino, 2017). Besides within the cluster, coopetition may also appear between the clusters located in same area and operating within similar fields (Cusin and Loubaresse, 2018).

Building on the existing literature, this paper aims for specific, micro-level insights regarding the influence that RPs and clusters, as non-competitive partners, have on competitor-to-competitor relationships. To capture indicated peculiarities of different phases in research–industry collaboration (Rybnicek and Königsgruber, 2019; Alexander *et al.*, 2020), this paper focuses on two project phases: the initiation and planning phase or "pre-project phase" (Hill *et al.*, 1988); and the project implementation phase that starts after a kick-off meeting, as suggested in PMBOK Guide (2013).

3 Research Design

Adopted case research methodology (Yin, 2003; Zomerdijk and Voss, 2011) is appropriate for the explorative nature of this research and theory building (Eisenhardt and Graebner, 2007). The unit of analysis is a project, and the sample

consists of strategically selected coopetitive R&D projects involving competing companies and RPs and clusters, as non-competitive partners. In line with the chosen unit of analysis, this paper focuses on micro-level, project participants. To identify projects that enable the learning process, the starting point in sampling was a dialogue with two managers in a business cluster of firms in the mature oil and maritime industries of Norway. This cluster has been awarded and labelled as highly innovation- and collaboration-oriented. Based on the dialogue and publicly available information, five coopetitive R&D projects were identified and selected as cases for this study. Participants in all sampled projects were RPs, business clusters, two or more competitors, and at least one customer or supplier.

All projects were innovation-oriented and involved competing companies producing equipement for the oil, gas and maritime industries. Project Alpha was established with the aim of developing new technology and the aim of Project Beta was developing and implementing a new test laboratory. Project Gamma aimed to develop a new analysis model to comply with new environmental regulations while business model innovation (Aas *et al.,* 2018) was the aim of Projects Delta and Epsilon. Of the five projects in the sample, four reached the implementation phase, while one was finalised at the time of the investigation.

Data were collected through semi-structured, in-depth interviews with key informants from each project. An interview guide was developed to ensure common understanding of the phenomenon and purpose of the questions (see Appendix A). There were 45 in-depth semi-structured interviews conducted, including nine follow-up interviews, with decision-makers from high- and middle-level management of competing companies, project managers, cluster managers and employees from RPs involved in the projects. Most of the interviews were conducted in person, and eight of the follow-ups were conducted over Skype. Interviews varied in length between 60 and 90 minutes. All interviews were recorded and transcribed. Characteristics of the selected projects and information about the informants are presented in Table 1.

Table 1: The sample

Project	**Participants**	**Description and Status**	**Funding**	**Informants**	
Alpha	Initiated by the university and the business cluster.	The aim of the project was technology development. The interviews were conducted during the	Funded partially by the Research Council of Norway and companies.	CM RCe Ue	16

	Participants: Four universities, two research institutes, one business cluster, four competing companies and a few non-competing companies.	project implementation phase.		HLM MLM	
Beta	Initiated by the university and the business cluster. Participants: One university, one business cluster, four competing companies, and a few other non-competing companies.	The aim of the project was to develop and implement a new test laboratory. The interviews were conducted after the project's finalisation.	The university funded the establishment, but the laboratory needs to work according to market principles.	CM Ue HLM MLM	6
Gama	Initiated by the business cluster and companies. Participants: One university, one business cluster, four competing companies and several non-competing companies.	The aim of the project was to develop analysis model in line with new environmental regulations. The interviews were conducted during the project implementation phase.	Funded partially by Innovation Norway and companies.	CM Ue MLM HLM	4
Delta	Initiated by the university and the business cluster. Participants: One university, one business	The aim of the project was to develop new service-oriented business models. Interviews were conducted during the pre-project and project implementation phases.	Funded partially by the Research Council of Norway and companies.	CM RCe HLM	5

	cluster, one research centre, two competing companies and a few non-competing companies.				
Epsilon	Initiated by the university and company. Participants: Two universities, one research centre, two business clusters, two competing companies and a few non-competing companies.	The aim of the project was to develop new service-oriented business models. The interviews were conducted during the pre-project and project implementation phases.	Funded partially by the Research Council of Norway and companies.	CM Ue RCe HLM MLM	5

Legend
CM: Cluster manager
RCe: Research Centre employee
Ue: University employee
HLM: High-level manager (CEO, vice president, R&D director)
MLM: Mid-level manager

Data analysis was performed in an inductive manner and followed three steps: coding, within-case analysis and cross-case analysis. Nvivo 12 software was used as a tool in a two-step coding process (Miles, Huberman and Saldaña, 2014) where all information about the role and influence of RPs and clusters was descriptively summarised in respect to the two specific project phases. Descriptive codes were then grouped into explanatory categories thorough an iterative process. Presentations from the companies and projects, as well as annual reports and publicly available information, were used to ensure better understanding of the interview data.

4 Findings

Data revealed that the roles of RPs and clusters differed during the pre-project and the project implementation phases. Their roles and influence on coopetitive relationship are presented in accordance with the project phases.

4.1 Roles and influences of RPs and clusters in the pre-project phase

Table 2 illustrates the roles and influences of RPs and clusters on coopetitive relationship in the pre-project phase.

Table 2: Roles of RPs and clusters in the pre-project phase

Role/Partner	**RPs**	**Clusters**
Establishing cooperation		Platform mechanism to accelerate innovation
	Idea generation	
	Research capabilities as a selling point offered to the companies	
	Writing the application	Lobbying for the project at Government level
	Leading the project— consortium agreement, organising the structure, defining the scope of work and establishing the rules	Leading the project— administrative lead, organising the structure in some cases
Balancing coopetition	A neutral partner between competing companies— Establishing data sharing vs. data protection mechanisms	No role

As presented, two roles became apparent in the pre-project phase:

1. Establishing cooperation; and
2. Balancing coopetition.

Data indicated RPs involvement in both roles, while clusters focused only on establishing cooperation. The following subsections elaborate on the effects both types of partners had on relationships between competing companies.

4.1.1 Establishing cooperation

Project ideas were generated in synergies between both partners in Projects Beta, Delta and Epsilon. In Project Alpha, the RPs produced the idea and the cluster created it in Project Gamma. According to the data, most contacts with competing companies were established throughout the cluster while cooperation was established. RPs, alone, had a lower number of direct relations with companies in all sampled projects, as indicated by one of the RP informants (University in Project Gamma):

> "Starting the cooperation with businesses, that's not what we are good at. He [manager from the cluster] has the competence on how to talk with the industry on managerial level ... and I think we should realise that we need a lubricant for getting the CEOs and CTOs to want to talk to us."

Another informant, a cluster manager and Project manager from Project Delta, illustrated the role of clusters in connecting RPs and companies: 'Linking business practice with academic theoretic knowledge and resources, kind of building a bridge between the researchers and key personnel in the companies.' Some of the RP informants, from university involved in Projects Alpha and Beta, indicated that direct communication with companies, required trust built over a long period prior to project initiatives. This was illustrated by the project manager in Project Alpha:

> "You have to build up the trust. When, and how do we approach them? That was long before the projects. We just wanted to build up relationships with the CEOs; you need to have them on your side. And, of course, you have to have the next layer, the heads of the technical development…We started to discuss with them what could this type of Professor do that they need. So we're not asking for money, we're just asking: 'Tell us what you need?'…That is what they like. So, they told us…you don't go to the industry always to ask for money, but you ask them for strategic advice."

The main selling point when establishing cooperation with companies was the research capabilities available in concrete projects. This was explained by a cluster manager, who acted as project manager for Project Delta:

> "I knew that with this research team, we can have a true impact for the companies. The task for me then was to convince the managers to be a

part of the project, where they will get access to the best capabilities. That was a selling point."

Project Alpha's project manager (a university informant) supported this: 'We need to impress them with the type of content that we have. And to convince them that the type of knowledge that we can bring to the table can help them solve their problem.' A middle-level manager from a company involved in Project Beta also provided confirmation: 'When you have a drive from the university that wants to be outstanding in these technologies, it fits very well…that is a great drive...and it has been a very, very good project for cooperation and development.'

Due to the importance of research capabilities when establishing cooperation, a lack of direct communication between competing companies and RPs caused lower success rates maintaining company interest in project participation. For instance, limited understanding and a lack of direct communication may be factors that contributed to one competing company leaving Project Delta later on. Its project manager explained that all communication was done by the cluster and that the lack of direct communication with RPs in the pre-project phase was certainly a drawback:

"But that is the mistake. I think if I should do that again, besides cluster representative on board, I'm going to bring the university with me…I think it's very important to bring the university early on board for companies to understand, see and talk to the person or the team."

Some tasks were clearly distinguished in all projects. RPs were in charge of writing the application while the clusters lobbied for higher governmental funding. Project leadership was dependent on the funding pre-requirements, some of the projects were led by RPs (University, for instance, in Projects Alpha, Beta and Epsilon) and some other by cluster (Projects Gamma and Delta). Nuances in the leadership role are presented in Table 2. Project Delta's project manager revealed a way to influence the relationship between competing companies in the early pre-project phase:

"We should have one point where we are bringing all the managers from all companies together to discuss objectives, to understand the risks, to understand each other and to build a relationship. Just to have a place where we all can meet and get to know before they have to say 'yes' to cooperation."

4.1.2 Balancing coopetition

As indicated in the Table 2, RPs had a dominant role in balancing coopetition during the pre-project phase. The main coopetitive issue in that phase was establishing appropriate data protection and data sharing mechanisms, which was illustrated by a high-level manager from a competing company involved in Project Alpha: 'This is not so simple, let's sit around the campfire and share our good ideas, and the rest will just pop up … there was a bit of tension between the industrial partners.' To resolve this issue, RPs were recognised as neutral partners that can ensure better cooperation between competing companies while simultaneously protecting their information. A high-level manager from a competing company involved in Project Delta confirmed this:

> "The researchers that come here and interview us will make sure that we can be open with them but will only share what is relevant for the project. They will not share that our company is here, and the competing company is there, or what we are doing internally."

Another high-level competing company manager involved in Project Alpha offered further explanation:

> "In the early beginning, RP was a neutral part, safety factor…probably like a best friend, that you can trust a hundred percent and you can tell that friend secrets that you don't want to reveal to anybody else. You could have a fruitful discussion with that person, and then, in the end, you could decide how much information would be revealed to the outside world…The cluster connected companies with university but cluster would not insure you secrecy if you are willing to share something. It is just like networking. They provided the network, but they were not able to provide the necessary trust and the necessary feeling of being able to protect the secrets."

4.2 Roles and influences of RPs and clusters in the project implementation phase

Table 3 illustrates the roles and influences of RPs and clusters on coopetitive relationship in the project implementation phase.

Table 3: Roles of research partners and clusters in the project implementation phase

Role/Partner	RPs	Clusters
Enabling cooperation	Participation in project governance (e.g., position in steering board)	Participation in project governance (e.g., steering board)
	Leading the project—full managerial role (decisions about organisational structure, contribution, rules, tensions)	Leading the project— administrative managerial role
Knowledge creation and dissemination	Enabling technology	Communication with companies to identify potential spin-offs
	Creating scientific knowledge	Results dissemination
	Creating problem-solving, practical knowledge	
Balancing coopetition	Neutral partner in between competing companies—ensuring information sharing necessary for project continuity	No role
	Actor causing tensions regarding an increased need for information	
	Establishing new modalities for collaboration between competing companies	

Table 3 indicates three apparent roles in the project implementation phase:

1. Enabling cooperation;
2. Knowledge creation and dissemination; and
3. Balancing coopetition.

Data indicated the involvement of RPs in all roles, while clusters were focused on enabling cooperation with very limited roles in knowledge dissemination. The following subsections elaborate on the effect that both types of partners had on relationships between competing companies.

4.2.1 Enabling cooperation

Clusters and RPs were both involved in project governance, holding positions in several managerial bodies. An RP (university) informant in Project Alpha

explained the role of a steering board in terms of steering the project, resources and budget:

> "I'm sitting on the board, part of the board for negotiation. And we steer how we would like the project to run, make the decisions and so on. We have budgets, we have resources we're going to use, we have to look at the feedback …checking if the project is following the plan, on the one side but also making new decisions on the changes."

Regarding leadership roles, RPs were assigned to tasks related to organisational structures, roles, contributions and resolving tensions, even in cases where a cluster was leading the project. That being said, even when a cluster led a project, it was placed in charge mainly for project administration. This was indicated by an RP (research centre) informant with Project Delta:

> "He's [cluster manager leading the project] the one organising and being sort of the administrator of the project, and that is so helpful because it can take so much time for organising; you know, just for you to get an interview with me now it takes time to organise everything. We have him doing it all, which means that we can really focus on what we need to do here with that company instead of using our time with administration."

4.2.2 Knowledge creation and dissemination

This role emerged in the project implementation phase and revealed a clear distinction between RPs (responsible for knowledge creation) and clusters (responsible for knowledge dissemination). Our informants indicated that RPs were responsible for enabling technologies, creating scientific knowledge and creating problem-solving, practical knowledge. To illustrate, a high-level manager from a company in Project Beta explained:

> "The university would bring all the scientific knowledge into it. The users would be the companies, they would have the problem they need to verify and test. The university will provide the scientific people to do the verification, getting the result documented."

Another high-level manager from a company involved in Project Alpha confirmed this: 'They were not developing products. They were developing technology or knowledge.' A high-level manager from the company involved in Project Epsilon offered additional clarification: 'Their role is to describe what is

happening within digitisation and what kind of business models have been used and what's happening in other businesses, and can we learn something from that.'

The role of cluster in Project Epsilon was solely dissemination of the results, as indicated by the cluster manager: 'We have a very small role now just to be informed about the main findings in the project and disseminate them…that could be an open seminar, or just a web-article or news article in our newsletter.'

A more important role of clusters was evident in Project Alpha. The cluster was leading a work package aiming for identification of potential spin-offs throughout communication with competing companies. As elaborated by the work package leader and cluster manager:

> "We are aiming at having at least one one-to-one meeting with each company every year. We spend one to two hours discussing the progress, quality, what they don't like what they want to see more in the future, how we can help to bring the results into the companies and make new spin-off projects."

Due to the specific role of RPs in knowledge creation in the project implementation phase, competing companies established good direct communication with RPs. In this project phase, they communicate without the mediation of the cluster, as was the case in the pre-project phase. As summarised by a middle-level manager from a company involved in Project Alpha, 'If we want to know more about the project and get more involved since that is interesting for business or knowledge development...we will approach the scientific personnel directly.'

4.2.3 Balancing coopetition

The same as in the pre-project phase, data indicated the dominant role of RPs in balancing coopetition in the project implementation phase. Two roles of RPs in relation to information sharing became apparent. The majority of the companies in the sample projects recognised RPs as neutral partners with a significant role in enabling data sharing that is necessary for the continuity of the project. A high-level manager from a competing company in Project Alpha explained as follows:

> "If the discussion had only been between the companies, the companies would have been very afraid that competitor would steal their trade secrets and they wouldn't trust each other in such a sense that they could

> reveal important information. But the role of the university made it possible to have all the vital information entered into the project and still the companies would be safe and nobody would know their trade secrets. They were like safety wale."

However, when RPs would increase the requirements for information sharing, some companies may perceive them as a source of tensions. One middle-level manager from another competing company in Project Alpha clarified this perception as follows:

> "It could be a challenge for the university that they know that there are some activities in the companies that they will not see because of our competitors …they can't get all the information they want from the companies because we want to be even more generic…in some cases, unfortunately, we have to be more restrictive on that, and we have got some feedback from the university that that is a problem."

In Project Epsilon, RPs had to establish new modalities and ways to work with competing companies while balancing coopetition, as emphasized by an RP (research centre) informant:

> "Now we can't have workshops with both of them together… The only thing we have to do is to ensure that they are not in the same room in the same workshops because they then don't want to talk. So, we will have one workshop with one company, and then one workshop with the other…that is what we need to do to handle these challenges since it is crossing the line; it's close to their competitive edge."

5 Discussion and implications

This study examined the influence of RPs and clusters on relationships between competing companies in two distinct project phases (pre-project and project implementation phases) of five coopetitive R&D projects. The competing companies in the selected projects were producers of equipment for oil and gas and maritime industries. All the projects were embedded in the same industrial setting—mature industries in Norway—and had mixed public-private sources of funding.

Similarly to findings from phase-oriented research–industry literature (e.g., Estrada *et al.*, 2016), the findings of this study indicate that the influence of RPs and clusters vary between the pre-project and project implementation phases. The findings revealed that business clusters are very important for negotiations in the pre-project phase, as they have many direct relations with competing companies. This is in line with the expected role of clusters in facilitating collaboration between the industry and RPs towards improvement of regional innovation performance (Nishimura and Okamuro, 2011). RPs, on the other hand, have a lower number of direct relationships with companies and rely more on indirect relationships through clusters. As research capacity and potential are major selling points for R&D projects, a lack of direct communication between RPs and companies or a lack of simultaneous communication between clusters, RPs and competitors resulted in lower success rates in keeping the companies interested in participating in projects. Therefore, the findings confirmed that efficient communication directly influences the establishment of projects (Plewa *et al.*, 2013) and, consequently, the relational success of research–industry collaboration (Boehm and Hogan, 2013), as indicated in the first proposition of this study:

> P1: Simultaneous communication between competing companies, RPs and clusters during the pre-project phase increases the likelihood of the establishment of coopetitive R&D projects in mature industries.

The findings also indicated that RPs are crucial for building trust and convincing companies in project's relevance (from the knowledge creation side) and information safety (from coopetitive side). Thus, RPs have a dominant role in balancing coopetition in the pre-project phase. These findings are in line with, for instance, those of Czakon and Czernek (2016), who indicated the importance of the reputation and legitimacy of third-party when competing companies are deciding to enter coopetitive networks. As a distinction from Plewa *et al.* (2013), who stress the importance of trust in the initiation phase and understanding in the later engagement phase of research–industry collaboration, our findings revealed that both trust, based on the credibility and expertise of RPs, and understanding are of crucial importance for the establishment of collaborations. These differences in findings could be attributed to the coopetitive nature of the projects. Therefore, even if companies in mature industries may be more willing to collaborate with RPs compared to those in emergent industries (Freitas, Marques and Silva, 2013), effective communication, understanding and trust are necessary for the decision

to engage in R&D collaboration with competitive partners. This leads to the second proposition:

> P2: Information support provided to competing companies by RPs and trust in RPs during the pre-project phase increase the likelihood of the establishment of coopetitive R&D projects in mature industries.

In the project implementation phase, cluster has the same role in enabling collaboration, a limited role in knowledge dissemination and no role in balancing coopetition. Therefore, RPs maintain a dominant role in balancing coopetition in this phase of coopetitive R&D projects in mature industries. At this point, they are 'in the middle' between competing companies and have plenty of contacts with all of them to enable knowledge creation and knowledge flows. The role of RPs in balancing coopetition is realised throughout the establishment of new modes of collaboration, such as separate relations with competing companies, when RPs act as a mechanism for data sharing and protection. In this way, information tensions are mitigated, and the continuity of the project is ensured. Coopetition literature has discussed mechanisms and practices for solving information tensions (Fernandez and Chiambaretto, 2016; Tidström, Ritala and Lainema, 2018), but the role of non-coopetitive partners in establishing those mechanisms hasn't been considered yet. Communication and coordination have been found to be particularly important in multi-partner R&D projects (Hamadi, Leker and Meerholz, 2018). When it comes to R&D networks, Ritala *et al.* (2017) noted that coordination efforts performed by a third party may support goal alignment and mitigate interdependence risks. As indicated in phase-oriented research–industry literature, routine-based dissimilarities between partners may remain hidden in the early stage of collaboration and start hampering collaboration and its outcomes in the later stages (Estrada *et al.*, 2016). Following that, involvement of RPs in managing tensions between competing companies in the implementation phase can be explained as a coordination effort that fosters adjustments in collaborative routines between competitive partners with aim of ensuring desirable outcomes of the projects. This finding contradicts the statements of Ruangpermpool, Igel and Siengthai (2020) about a higher level of trust and a lower level of coordination and control in the project implementation phase of non-competitive R&D alliances. Knowledge sharing and protection mechanisms appear to be dependent on the relational factors and coopetitive nature of collaboration (Bogers, 2011), as indicated in the third proposition:

P3: The involvement of RPs in the management of information tensions between competing companies during the project implementation phase increases the likelihood that those tensions will be successfully resolved in coopetitive R&D projects in mature industries.

Successful R&D collaboration relies on effective knowledge and technology transfer (Rybnicek and Königsgruber, 2019). However, our findings indicated that, when increasing requirements for data sharing in the project implementation phase, RPs might be considered a source of tensions by competing companies. Ritala *et al.* (2017) pointed out that companies within R&D networks may have different expectations for reciprocal knowledge sharing or different perceptions regarding risks of knowledge leaking, which might influence variations in their information-sharing attitudes. Our findings may also resonate with the attitudinal misalignment of RPs and companies discussed in research–industry literature (Hamadi, Leker and Meerholz, 2018) Academics aim to publish their research before it become obsolete, whereas industry is afraid of knowledge leaking that might erode their competitive advantage (Ankrah *et al.*, 2013). Another aspect that needs to be considered is the context of mature industries. Challenges in balancing between open and traditionally more closed innovation practices of companies in mature industries (Boscherini *et al.*, 2012; Caiazza, 2015) may impede their openness to sharing information in research–industry collaboration (Fontana, Geuna and Matt, 2006). Lastly, while a lower level of coordination is evident in the later stages of non-coopetitive R&D projects (Ruangpermpool, Igel and Siengthai, 2020), reciprocal communication (Bstieler, Hemmert and Barczak, 2015) and adaptation of collaborative routines between RPs and industry becomes very important in the implementation phase of coopetitive R&D projects in mature industries. On the basis of the above findings, the final proposition is as follows:

P4: In the case that RPs increase requirements for data sharing during the project implementation phase in coopetitive R&D projects in mature industries, some competing companies may consider the RPs to be a source of tension.

5.1 Theoretical implications

The findings offer several theoretical insights. On the one hand, the adopted case study contributes to a richer theoretical understanding of multi-partner R&D projects in mature industries. Building on research about phase-specific

management of increasingly complex research-industry collaboration (Estrada *et al.*, 2016; Alexander *et al.*, 2020), this paper provides a more integrative view of relational aspects in R&D projects that involve both competitive and non-competitive partners. Disentangling their joint effect on collaborative processes in different project phases reveals the specific communication, knowledge creation and coordination mechanisms needed to ensure desirable outcomes in this context. Furthermore, insights about the importance of non-competitive partners for the establishment, collaboration and knowledge flow in coopetitive R&D projects contribute to debates about the peculiarities of innovation processes and knowledge in mature industries (Bodas Freitas, Marques and Silva, 2013). On the other hand, this paper contributes to existing coopetition research by explaining the evolution of the roles and effects that non-competitive partners, RPs and clusters, may have on focal coopetitive relationships during different project phases. The findings revealed the need for the simultaneous involvement of both RPs and clusters for the establishment of collaboration in the pre-project phase, while RPs have a dominant role in balancing coopetition in both the pre-project and project implementation phases. Therefore, while shaping collaborative processes and mitigating coopetitive difficulties over collaboration lifetime, non-competitive partners certainly influence the relational success and outcomes of the projects. Lastly, the paper shows how two research streams can complement each other. An important contribution of this study is also a set of propositions that will hopefully inform future studies in both fields.

5.2 Practical implications

This study increases the awareness of project managers, competing companies, RPs and business clusters regarding the possible consequences of the complex interactions during competitive R&D projects in mature industries and helps all partners act knowledgeably. The understanding of the influence that non-competitive partners, in particular RPs and clusters, have on competitor-to-competitor relationships may improve collaboration, knowledge creation and consequently, the outcome of coopetitive R&D projects in mature industries. Since research-industry collaboration is one of the priorities on policy agendas (Alexander *et al.*, 2020), unpacking the relationships in coopetitive R&D projects also generates valuable insights for the definition and optimisation of innovation policies.

The limitations of this study may provide potential avenues for further research. While this investigation solely focuses on the context of mature industries, future research may provide comparative insights from coopetitive R&D projects in both mature and emergent industries. Most of the sampled projects have reached the implementation phase, and further investigation may also include the finalisation phase of the collaboration lifecycle and reflect on the collaborative outcomes. Furthermore, the policy perspective was beyond the scope of this study, and future studies could explore the influence that policy makers have on the relationships between competitive and non-competitive partners, as well as which type of policies and strategies can stimulate R&D collaborations in this context.

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Appendix A: Interview guide

The pre-project phase

- What did the pre-project phase look like?
- Who were the competitive and non-competitive partners involved in this phase?
- What were their aims and interests?
- What was the role of the clusters?
- What was the role of the RPs?
- What type of knowledge do competing companies try to obtain in this type of project?
- What were the coopetitive challenges in this phase?
- What was the role of the cluster and the RPs regarding those challenges?
- How were those challenges solved?
- What is the most important thing for relationships between competing companies in this phase?
- How did the clusters and RPs influence the relationship between competing companies in this phase?
- Which collaborative aspects need to be improved in this project phase?

The project implementation phase

- What did the project implementation phase look like?
- Who were the competitive and non-competitive partners involved in this phase?
- What were their aims and interests?
- What was the role of the cluster?
- What was the role of the RPs?
- How did the roles of clusters and RPs differ compared to the pre-project phase?
- What were coopetitive challenges in this phase?
- What was the role of cluster and RPs regarding those challenges in this phase?
- How were those challenges solved?
- What is the most important thing for relationships between competing companies in this phase?

- How did the clusters and RPs influence the relationship between competing companies in this phase?
- Which collaborative aspects need to be improved in this project phase?