

# Where there's a will, there's a way: The role of innovation capabilities in the development of innovation outputs

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PhD in Business  
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Maryna Vakulenko, Mo i Rana, October 4, 2022

## Abstract

The modern business environment is changing unexpectedly and unpredictably. Responding to these changes, some companies are able to innovate, recognizing new ways to stay competitive, while others continue to tread the beaten track, gradually losing their competitive edge. This dissertation explores the role of organizational innovation capabilities in the development of innovation (outputs). Moreover, I look to the emerging literature to distinguish between the internal and external aspects of organizational innovation capabilities, activities associated with them, and their manifestation in organizations and projects. In this dissertation, I use three different surveys and perform quantitative analysis to understand the role of organizational innovation capabilities in the development of innovation outputs.

This dissertation consists of an introductory part and three independent research papers. Although all three research papers are quantitative and empirical, they make conceptual and theoretical contributions. Paper 1 explores internal aspects of innovation capabilities, revealing the different ways organizational innovation capabilities influence companies' ability to develop innovation outputs depending on their size. Paper 2 investigates external aspects of innovation capabilities in terms of scientific and business collaboration, both of which contribute to the development of innovation outputs. Paper 3 looks into both internal and external aspects of organizational innovation capabilities and their influence on innovation outputs in projects.

The overall findings of this dissertation show that both internal and external aspects of organizational innovation capabilities are important for firms aiming to develop innovation outputs. In this dissertation, a number of implications are drawn, and avenues for further research on innovation capabilities are presented.





## Sammendrag

Det moderne forretningsmiljøet endrer seg uventet og uforutsigbart. Som svar på disse endringene er noen selskaper i stand til å innovere, og gjenkjenner nye måter å holde seg konkurransedyktige på, mens andre fortsetter å bevege seg langs kjente stier og gradvis mister konkurransefortrinnet. Denne avhandlingen utforsker organisatoriske innovasjonsevners rolle i utviklingen av innovasjon (outputs). Videre presenterer jeg på den nyeste innovasjonslitteraturen for å skille mellom de interne og eksterne aspektene ved organisatoriske innovasjonsevner, aktiviteter knyttet til dem, og deres manifestasjon i organisasjoner og prosjekter. I denne avhandlingen bruker jeg tre ulike datakilder og utfører kvantitative analyse for å bedre forstå rollen til organisatoriske innovasjonsevner i utviklingen av innovasjonsresultater.

Denne avhandlingen består av en innledende del og tre uavhengige forskningsartikler. Selv om alle tre forskningsoppgavene er kvantitative og empiriske, gir de konseptuelle og teoretiske bidrag. Artikkel 1 utforsker interne aspekter ved innovasjonsevner, og fremhever de ulike måtene organisatoriske innovasjonsevner påvirker bedrifters evne til å utvikle innovasjonsresultater. Paper 2 undersøker eksterne aspekter ved innovasjonsevner når det gjelder vitenskapelig og forretningsmessig samarbeid. Begge disse bidrar til utvikling av innovasjonsresultater. Paper 3 ser på både interne og eksterne aspekter ved organisatoriske innovasjonsevner og deres innflytelse på innovasjonsresultater i prosjekter.

De overordnede funnene i denne avhandlingen viser at både interne og eksterne aspekter ved organisatoriske innovasjonsevner er viktige for bedrifter som ønsker å utvikle innovasjonsresultater. Til slutt trekkes en rekke implikasjoner og veier for videre forskning på innovasjonsevner presenteres.



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# 1 Introduction

*“If you want something new,  
you have to stop doing something old.”  
—Peter F. Drucker*

Organizations’ ability to develop innovation outputs is a major enabler of economic growth and the modus operandi to address socio-economic challenges. Innovation outputs have been found to be key enablers for firms’ continuous ability to stay competitive (Kahn, 2018). In this regard, to ensure a steady stream of innovation outputs (e.g., products, services, processes, or business models) (McKinsey, 2021), a firm needs to constantly search for new ideas and resources—both internally and externally—to be able to innovate. However, some firms are more innovative than others, which can be attributed to their *innovation capabilities* (Lawson & Samson, 2001). One notable example of innovation capabilities that have resulted in innovation outputs comes from Tesla Motors, Inc., (Teece, 2018). Tesla’s innovation capabilities are embodied in its ability to generate and explore radical technological (e.g., battery, reliable software updates) and non-technological ideas (e.g., new models for distribution channels) and in its skills and knowledge that facilitate the creation of new technologies (Kim, 2020). By virtue of Tesla’s innovation capabilities, the company introduced one of its key innovation outputs—the lithium ion battery—which allows electric cars to travel long distances, thereby causing the rise in demand for electric vehicles and convincing many customers to buy their first electric vehicles.

In this thesis, I follow the understanding of innovation as “the introduction of something new” (Kahn, 2018, p. 454). I focus particularly on firms’ ability to introduce new products, processes, services, marketing innovation outputs, business models, and organizational innovation outputs (ibid). As such, this thesis directs attention to the outputs of the innovation process as it manifests within firms. I draw on the

concept of innovation capabilities when seeking to understand why firms are able to develop innovation outputs.

The term *innovation capabilities*, which is regarded as “a relatively new phenomenon” (Iddris, 2016, p. 255), refers to “the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders” (Lawson & Samson, 2001, p. 384). Essentially, innovation capabilities direct attention to firms’ capacity for innovation, which should not be confused with an innovation output (Kahn, 2018). Hence, in some sense, having innovation capabilities can be recognized as an important condition for the introduction of innovation outputs that allow firms to stay competitive. While many theoretical and conceptual studies highlight innovation capabilities as a key source of innovation at the firm level (Guan & Ma, 2003; Hii & Neely, 2000; Iddris, 2016; Maldonado-Guzmán, Garza-Reyes, Pinzón-Castro, & Kumar, 2019; Stezano & Espinoza, 2019; Yam, Guan, Pun, & Tang, 2004), there is still a need to advance our understanding of their relationship with innovation (Molden & Clausen, 2020; Iddris, 2016; Kahn, 2018). In particular, scholars highlight the need to distinguish innovation capabilities more clearly from the innovation process and the resulting outputs. Indeed, there has been a tendency in extant research to confound innovation capabilities with actual innovation (Kahn, 2018). Therefore, the relationship between innovation capabilities and actual innovation is still unclear (ibid). Accordingly, this dissertation aims to distinguish the phenomena of “innovation” and “innovation capabilities,” their relationship, and the role of innovation capabilities in organizations’ ability to develop innovation outputs.

## **1.1 Research topic: Innovation and organizational innovation capabilities**

This dissertation explores the role of innovation capabilities in the development of innovation outputs in organizations. Indeed, the number of management scholars interested in researching capabilities is constantly growing (Schilke, Hu, & Helfat,

2018). The study of innovation capabilities originates from the innovation management field (Breznik & Hisrich, 2014), but the concept is now widely employed in other areas, such as knowledge management (e.g., Lin, 2007; Prajogo & Ahmed, 2006), leadership (e.g., Lei, Leaungkhamma, & Le, 2020; Schweitzer, 2014), organizational culture (e.g., Çakar & Ertürk, 2010; Lawson & Samson, 2001), organizational learning (e.g., Aggeri, Elmquist, & Pohl, 2009; Calantone, Cavusgil, & Zhao, 2002), collaboration (e.g., Liao, Hu, & Shih, 2021; Soosay, Hyland, & Ferrer, 2008; Swink, 2006), and creativity (e.g., Ferreira, Coelho, & Moutinho, 2020; Le & Lei, 2019), among other fields. Therefore, the purpose of this dissertation is to add to this discussion by examining the relationship between organizational innovation capabilities and innovation (outputs), asking the following overall question:

*RQ: What is the role of organizational innovation capabilities in the development of innovation outputs?*

## 1.2 Sub-research questions: Internal and external aspects of organizational innovation capabilities

Since the prominent work of Lawson and Samson, (2001), scholars have continued the discussion of the role of innovation capabilities in innovation in organizations. In this regard, one promising line of development is increasing acknowledgement that organizational innovation capabilities rely upon both a firm's internal resources and its external inter-organizational relationships (Molden & Clausen, 2020; Mendoza-Silva, 2020). Reflecting this, there have been increasing calls to examine the role of internal and external innovation capabilities in the development of innovation outputs in organizations, including the ways innovation capabilities manifest and influence firms' innovation outputs. Further, we have an incomplete understanding of the relative performance effects (Schilke et al., 2018) of internal and external organizational innovation capabilities. Hence, to understand the role of organizational innovation capabilities firms' innovation output, the *internal* and *external* aspects of innovation

capabilities (Molden & Clausen, 2020) are investigated as sub-research questions of this dissertation.

First, the *internal aspects* of innovation capabilities focus on the processes and activities that stimulate firms' innovation and take place *inside* organizations. Such processes and activities form the basis for the development of internal innovation capabilities and include the recognition of lucrative opportunities/innovative ideas (Withers, Drnevich, & Marino, 2011), internal search (Katila & Ahuja, 2002), resource orchestration to develop recognized opportunities/ideas (Duran, Kammerlander, Van Essen, & Zellweger, 2016), internal competence development (Teece, 2007), internal learning processes (Zollo & Winter, 2002), and learning-by-doing activities (experiments) (Eisenhardt & Martin, 2000). Despite the importance of the topic, there are few studies focusing on the role of internal innovation capabilities in relation to the introduction of different types of innovation (Molden & Clausen, 2020). This is particularly important since, in general, internal innovation capabilities may enhance firms' innovation outputs (Molden & Clausen, 2020). Thus, we need more nuanced insights into the topic. Accordingly, the first sub-research question of this dissertation addresses the internal aspects of organizational innovation capabilities:

*SRQ1: What is the role of internal organizational innovation capabilities in the development of innovation outputs?*

Next, the *external aspects* of innovation capabilities focus on the external knowledge, cooperation activities, and relationships with actors outside the firm influence the development of innovation outputs. In particular, such activities include networking (Laursen & Salter, 2006), external learning (Mothe & Thi, 2010), open search (Laursen & Salter, 2006), collaboration (Molden & Clausen, 2020), and innovation modes (Jensen, Johnson, Lorenz, Lundvall, & Lundvall, 2007). Moreover, external innovation capabilities depend on firms' relationships with diverse actors (Molden & Clausen, 2020), which constitute their external networks and are thus important for firms' ability to introduce innovation (Cohen & Levinthal, 1990). Except for the Molden and

Clausen's (2020) article, there is a lack of empirical research on the external aspects of innovation capabilities and its role in the development of innovation outputs in organizations. Hence, the second sub-research question of this dissertation addresses the external aspects of innovation capabilities:

*SRQ2: What is the role of external organizational innovation capabilities in the development of innovation outputs?*

Finally, we still know little about the role of both internal and external organizational innovation capabilities *in the development of technological and non-technological innovation outputs* (Molden & Clausen, 2020) at the lower levels within organizational units (Iddris, 2016). Since some research suggests that innovation capabilities have a positive effect on innovation outputs at the firm level (Romijn & Albaladejo, 2002; Saenz & Perez-Bouvier, 2014), one may assume internal and external innovation capabilities have identical effects in projects. Moreover, regarding previous research on internal (Molden & Clausen, 2020) and external (Saenz & Perez-Bouvier, 2014; Molden & Clausen, 2020) innovation capabilities confirming the positive effect on innovation outputs, one may assume that building internal and external organizational innovation capabilities is equally beneficial for technological and non-technological innovation outputs. However, there is a lack of knowledge about the impact of both internal and external organizational innovation capabilities on the development of different types of innovation outputs (Molden & Clausen, 2020). Moreover, a large part of previous research explores the long-run effects of innovation capabilities on innovation in firms (Iddris, 2016) but neglects the short-term results generated by projects within organizations, thus leaving a gap in our understanding of the role organizational innovation capabilities play at lower levels (e.g., the project level). In this regard, I explore the effect of internal and external organizational innovation capabilities on technological and non-technological innovation outputs in projects, posing the third sub-research question:

*SRQ3: To what extent do both internal and external organizational innovation capabilities contribute to the development of innovation outputs in projects?*

Consequently, this dissertation investigates both the internal (SRQ1) and external (SRQ2) perspectives of organizational innovation capabilities and the role of each in the development of particular innovation outputs in projects (SRQ3), thereby contributing to a deeper understanding of the complexity of innovation capabilities in terms of firms' ability to develop innovation outputs.

### 1.3 Research papers

The overall research question and the three sub-research questions are answered in three individual papers, as summarized in Table 1.1.

Table 1.1 Proposed research papers and key essence of the papers.

<b>Research Paper</b>	<b>Research Question in the Paper</b>	<b>Sub-Research Question of the Dissertation</b>	<b>Essence of the Paper</b>
1	To what extent do innovation capabilities enable companies to generate more innovative outputs and overcome the liability of smallness?	SRQ1	Focus on the internal aspects of innovation capabilities and their role in the development of innovation outputs among firms of different sizes
2	To what extent does DUI collaboration mediate STI collaboration's influence on technological and non-technological innovation?	SRQ2	Focus on the external aspects of innovation capabilities and their role in the development of both technological and non-technological innovation outputs in organizations
3	What is the role of organizational innovation capabilities in innovation at the project level?	SRQ3	Focus on the extent to which internal and external innovation capabilities contribute to the development of both technological and non-technological innovation outputs in projects

Paper 1 addresses SRQ1 and contributes to our understanding of innovation capabilities' role in the development of innovation outputs while also contributing to the internal perspective. Particularly, Paper 1 clarifies the role of innovation capabilities, which facilitate firms' innovation outputs through the recognition and orchestration of internal means. Paper 2 reveals the external perspective of innovation capabilities, which is relevant to SRQ2. Considering scientific and business collaboration that enable organizations to acquire explicit and tacit knowledge (embodied in the science, technology, and innovation [STI] and doing, using, and interacting [DUI] innovation modes, respectively), Paper 2 explores the complementary/substitutional effect of the STI and DUI innovation modes. Both Paper 1 and Paper 2 examine the ways organizational innovation capabilities manifest at the firm level. Finally, Paper 3 contributes to answering SRQ3 and the overall research question examining the effect of internal and external organizational innovation capabilities on the development of innovation outputs in projects within organizations.

Combined, all three papers contribute to answering SRQ1, SRQ2, and SRQ3 and thus the overall research question. Together, the first two papers shed light on internal and external innovation capabilities' role in the development of innovation outputs in organizations, thereby addressing SRQ1 and SRQ2. Paper 3 provides insights into the effect of internal and external innovation capabilities in projects, responding to SRQ3 and partially answering SRQ1 and SRQ2. Together, all three papers aim at bringing new insights to the innovation literature by clarifying the interaction between organizations' internal and external organizational innovation capabilities and innovation outputs.

Figure 1.1 shows the structure of this dissertation, clarifying how the overall research question is revealed in the three separate sub-research questions and how each paper contributes to answering the sub-research questions and the overall research question of this dissertation.

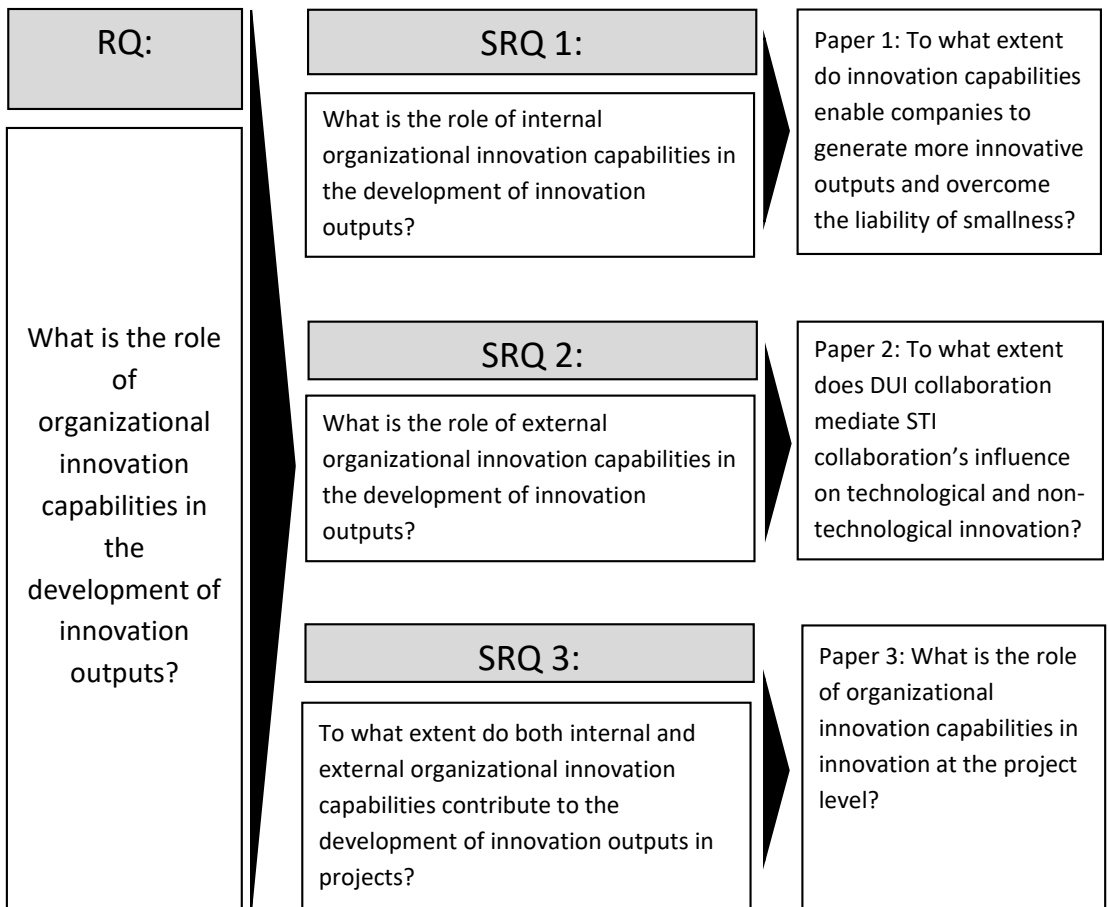


Figure 1.1 The structure of the dissertation.

## 1.4 Implications and contributions

Considering the phenomena of innovation capabilities and innovation, this dissertation delivers findings that reveal the interaction between organizational innovation capabilities and innovation outputs, thereby providing both theoretical and practical implications. Drawing on the debate about the role of innovation capabilities in the development of innovation outputs (Molden & Clausen, 2020), I introduce theoretical implications and contributions from three research papers that answer the main research question and sub-research questions of this dissertation.



The first paper contributes by investigating the internal aspects of innovation capabilities; it reveals the moderating role of innovation capabilities and suggests that innovation capabilities enable smaller companies to generate more innovative outputs and overcome the liability of smallness. The second paper contributes by revealing the role of external innovation capabilities, as expressed through the STI and DUI innovation modes, and their influence on the development of innovation outputs in organizations. This paper investigates the external aspects of innovation capabilities and provides support for the claim that business collaboration is a necessary precondition for executing scientific collaboration, which in turn stimulates organizations to develop innovation outputs in organizations. The third paper contributes by explaining the role of both internal and external innovation capabilities in the development of both technological and non-technological innovation outputs, thus enhancing knowledge of the ways organizational innovation capabilities manifest at the project level.

For practitioners attempting to implement innovation capabilities, this research is particularly useful since it proves that companies need to create, develop, and manage innovation capabilities to be able to innovate. These innovation capabilities must be properly defined, categorized, and organized to ensure that firms are able to innovate systematically and that firms do not rely on ad hoc processes and activities to innovate. Therefore, this study aims to encourage practitioners to properly manage organizational innovation capabilities since innovation outputs result from the thoughtful investment and management of particular innovation activities.

## **1.5 Dissertation structure**

This dissertation is organized as follows. Chapter 2 presents an overview of the literature on innovation and innovation capabilities and introduces the relevant research gaps. Chapter 3 describes the methodology of this dissertation and contains the philosophical perspective, research design (i.e., data collection, data sources, data-analysis strategy, and research-quality criteria), and ethical considerations. Chapter 4

provides a summary of the three papers of this dissertation. Chapter 5 discusses the findings and contributions. Finally, Chapter 6 introduces the three research papers of this dissertation.

## 2 Organizational innovation capabilities: Frame of reference

In this chapter, I discuss the main concepts and theoretical perspectives that I used to address the overall research question and sub-research questions of this dissertation. First, in this chapter, I review the literature on innovation and organizational innovation capabilities. Then, I discuss the theoretical perspectives employed in this dissertation and relate them to the key concepts in order to answer the research questions/fill the gaps in the innovation management literature.

### 2.1 Innovation

Innovation is widely recognized as a critical driver of economic development and a vital source of strategic change that enhances companies' performance and ensures a sustainable competitive advantage (Salavou, 2004). For this reason, innovation has been extensively investigated for decades (ibid). The term "innovation" was first introduced by a famous sociologist in the 19th century, Gabriel Tarde (1843–1904), who suggested that innovation may explain social changes, change the course of social development, and help individuals adapt to changing environments (Kinnunen, 1996). The pioneer of innovation in economics is a political economist, Joseph Alois Schumpeter (1883–1950), who distinguished innovation from invention, which he claimed meant a "discovery" (Fagerberg, 2003). Today, the phenomenon of innovation is rather generic and can be understood from three different perspectives: namely, as a *mindset*, as a *process*, and as an *outcome* (Kahn, 2018). Kahn (2018) suggested that innovation as a mindset involves the development of an innovative/creative culture in an organization; innovation as a process is the way to introduce innovation outputs; and innovation as an *outcome*<sup>1</sup> consists of product innovation, process innovation,

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<sup>1</sup> The extant innovation literature uses both "innovation outcome" and "innovation output" to refer to the same concept. In this dissertation, I apply the term "innovation output" (Kahn, 2018). In addition, I consider innovation as a process as the way to introduce innovation outputs (ibid).

marketing innovation, business-model innovation, supply-chain innovation, and organizational innovation.

Innovation from the *outcome* perspectives examines innovation outputs, such as new products, services, processes, technologies, organizational structures, and administrative systems (Damanpour, 1996) and the creation of new knowledge and ideas that contribute to achieving new business results (Du Plessis, 2007). Coming back to Kahn (2018), scientists adhere to different points of view regarding what innovation is, which has in turn given rise to numerous definitions of this phenomenon, as presented in Table 2.1.

Table 2.1 Definitions of innovation.

<b>Reference</b>	<b>Definition</b>	<b>View</b>
Schumpeter, 1934, p. 65 (Fagerberg, 2003, p. 131)	<i>New combinations of existing resources, equipment, and so on.</i>	Innovation as an outcome
Damanpour, 1996, p. 694	<i>A range of types, including new products or services, new process technologies, new organizational structures or administrative systems, or new plans or programs pertaining to organizational members.</i>	Innovation as an outcome
Du Plessis, 2007, p. 21	<i>The creation of new knowledge and ideas to facilitate new business outcomes.</i>	Innovation as an outcome
OECD, 2005, paragraph 146	<i>An 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.</i>	Innovation as an outcome
Kimberly, 1981, p. 108	<i>There are three stages of innovation: innovation as a process, innovation as a discrete item including, products, programs or services; and innovation as an attribute of organizations.</i>	Innovation as a process, a mindset, and an outcome
Kahn, 2018, p. 453	<i>Innovation is three different things: innovation is an outcome, innovation is a process, and innovation is a mindset.</i>	Innovation as a process, a mindset, and an outcome

Some authors distinguish between the scope of innovation (technical innovation and administrative innovation) and the degree of innovation (Lin et al., 2010). The degree of innovation is subdivided into *incremental* and *radical* innovation (Ettlie et al., 2019; Johnson et al., 2004). Earlier research mainly focused on radical and incremental types of *technological process innovation outputs*, while later research on radical and incremental innovation outputs began to capture innovation outputs in a broad technological and non-technological sense, exploring both new-to-the-firm and new-to-the-market products, processes, services, organizational structures, and marketing practices (Khan et al., 2021).

Initially, considering *innovation as an outcome*, the innovation literature classified innovation based on Schumpeter's ideas, dividing product and process innovation, which are also known as *technological innovation*. Nowadays, the innovation literature has expanded the concept of innovation by adding marketing and organizational innovation, so called *non-technological innovation* (Fagerberg et al. 2005). This research focuses on innovation as an outcome since technological and non-technological innovation outputs are important sources of competitive advantage for companies (Radicic & Djililov, 2019). As a rule, technological innovation outputs materialize in new product development, while non-technological innovation outputs emerge via organizational and marketing evolution (Siriram, 2022). In this regard, the *Oslo Manual* (OECD, 2005) identified four types of innovations, classifying them based on the technological (product innovation and process innovation) and non-technical (marketing innovation and organizational innovation) types of innovation outputs.

First, product innovation (technological innovation outputs) is represented by new or significantly improved goods or services. Product innovation "includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics" (Mothe & Thi, 2010, p. 315). Innovative products enable firms to obtain a temporary monopoly position in the

market, which allows them to set higher prices for innovative products (OECD, 2005, 2005).

Second, process innovation (technological innovation outputs) covers new or significantly improved production or delivery methods. Process innovation implies “changes in equipment, human resources, working methods or a combination of these” (Oslo Manual, 2005, p. 9). Process innovation is closely related to product innovation as the introduction of new products often requires changes in production processes that are new to a firm (Robertson et al., 2012). Moreover, if new goods or services prove to be successful, further changes in innovation processes may be necessary (ibid).

Third, marketing innovation (non-technological innovation outputs) implies new marketing methods that entail significant changes in marketing activities. According to the *Oslo Manual*, marketing innovation is “the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing” (OECD, 2005, p. 49). Rust et al. (2004) considered marketing innovation in terms of the following three aspects—(1) product strategy, (2) channel strategy, and (3) promotion strategy—which aim at changes in design, distribution, and advertisement, respectively. The purpose of marketing innovation is to increase the attractiveness of products or services and conquer new markets (Mothe & Thi, 2010).

Finally, organizational innovation (non-technological innovation outputs) embodies new organizational methods in organizing and coordinating business activities and workplaces. Organizational innovation refers to “the implementation of a new organizational method in the firm’s business practices, workplace organisation or external relations” (OECD, 2005, p. 51). According to Mothe and Thi, (2010) organizational innovation relies upon the following three aspects: (1) management practice embodied in teamwork, knowledge management, and flexible work arrangements; (2) production approaches related to quality management and business

re-engineering; and (3) external relationships materializing in outsourcing, networking, and customer contacts. Further, Martin-Rios and Parga-Dans (2016, p. 6) suggested that business-model innovation can be regarded as “non-technological, organizational sources of innovation.”

While technological innovation requires considerable resources and special conditions, non-technological innovation centers on commercial and organizational innovation outputs aimed at implementing new marketing methods (e.g., design, product placement, and promotion adjustments) and new organizational methods (Parrilli & Heras 2016). Non-technological innovation is directed toward gaining new markets, opening up new sources of supply, and creating new market structures, whereas organizational innovation involves the coordination of human resources (Apanasovich, 2016) and requires a lot of interaction between workers inside and outside a company (Fitjar & Rodríguez-Pose 2013). When pursuing non-technological innovation, firms generate knowledge in a different way (*vis-à-vis* technological innovation), which is associated with tacit knowledge, user-managed drivers, and non-technological innovation outputs (Apanasovich, 2016). Therefore, the development of technological innovation outputs may require different types of innovation activities and processes than the development of non-technological innovation outputs, which in turn demand a particular set of innovation capabilities. Indeed, the innovation literature, for the most part, focuses on the characteristics of innovative organizations and how to stimulate innovation in organization. Thus, there are some gaps in our understanding of the extent to which and how organizations’ ability to innovate influences their innovation outputs (Molden & Clausen, 2020). In order to understand the role of innovation capabilities in the introduction of innovation outputs, I first unpack the phenomenon of innovation capabilities in the following section.

## 2.2 Innovation capabilities

Lawson and Samson (2001) identified “innovation capability” as a higher-order integration capability and, at the same time, as an organization’s ability to introduce

innovation. These authors emphasized the leading role of innovation “in shaping the future of their industries” (p. 381), since market competition is driven by firms’ ability to innovate rather than the simple development of products. Some other researchers (Björkdahl & Börjesson, 2011; Martínez-Román, Gamero, & Tamayo, 2011; O’Connor, Paulson, & De Martino, 2008; Samson & Gloet, 2014; Saunila, Mäkimattila, & Salminen, 2014; Saunila & Ukko, 2014) have fully or partly employed this view in their studies, while still others have explored innovation capabilities from internal and external perspectives, highlighting the role of a firm’s resources, competences, and capabilities (Akman & Yilmaz, 2008; Elmquist & Le Masson, 2009). However, other researchers have emphasized different levels of perspectives on innovation capabilities (Guan & Ma, 2003). For instance, some capabilities studies follow the hierarchical dimensionalization of capabilities (Schilke et al., 2018), suggesting that innovation capabilities comprise lower-level capabilities, such as cognitive capabilities (e.g., absorptive capacity) (Ribeiro-Soriano, Urbano, Un, & Montoro-Sanchez, 2010), technological capabilities (Parrilli & Heras, 2016), entrepreneurial capabilities, networking capabilities (Forsman, 2011), and so on. This diversity of perspectives and directions implies that the definitions of innovative capabilities are complex and comprehensive (Martínez-Román et al., 2011). Since the definitions of innovation capabilities vary in the literature, a synthesis of the definitions is presented in Table 2.2.

Table 2.2 Definitions of innovation capabilities

Reference	Definition	Level
Lawson & Samson, 2001, p. 384	<i>The ability to continuously transform knowledge and ideas into new products, processes, and systems for the benefit of the firm and its stakeholders.</i>	Firm level
Rangone, 1999, p. 235	<i>Company’ ability to develop new products and processes, and achieve superior technological and/or management performance.</i>	Firm level
Romijn & Albaladejo, 2002, p. 1054	<i>The skills and knowledge needed to effectively absorb, master, and improve existing technologies and to create new ones.</i>	Firm level



Withers et al., 2011, p. 517	<i>Firm's ability to recognize an opportunity for innovation, and then combine firm resources and capabilities to successfully exploit the opportunity through innovation.</i>	Firm level
Xu, Lin, & Lin, 2008, p. 792	<i>Capacity of gaining access to, developing and implementing innovative technologies for designing and manufacturing.</i>	Firm level
Chen, 2009, p. 94	<i>Firm's capabilities, grounded in the processes, systems, and organizational structure, which can be applicable to the product or process innovation activities.</i>	Firm level
Koc, 2007, p. 375	<i>The continuous improvement of the overall capabilities and resources that the firm possesses to explore and exploit opportunities for developing new products to meet market needs.</i>	Firm level
Neely et al., 2001; Saunila & Ukko 2012, p. 992	<i>[A]n organisation's innovation capability can be described as its potential to generate innovative outputs</i>	Firm level
Akman & Yilmaz 2008, p. 79	<i>An important factor that facilitates an innovative organizational culture, characteristics of internal promoting activities, and capabilities of understanding and responding appropriately to the external environment.</i>	Firm level
Guan & Ma, 2003, p. 740	<i>[I]nnovation capability should be defined in a wide disperse scopes and levels in order to accord with the requirements of firm strategy and accommodate to special conditions and competition environment.</i>	Firm level
Panayides, 2006, p. 466	<i>Cultural readiness and appreciation for innovation.</i>	Supply-chain level
Elmqvist & Le Masson, 2009, p 137	<i>Firm's ability to 'generate and explore radical, new ideas and concepts, to experiment with solutions for potential opportunity patterns detected in the market's whitespace and to develop them into marketable and effective innovations, leveraging internal and external resources and competencies'.</i>	Project level
Wang & Dass, 2017, p 127	<i>Firm's ability to generate, accept, and implement new ideas, processes, products, or services, is one of the key resources that drive a firm's success in the marketplace.</i>	Multi-level

As shown in Table 2.2, the definitions of innovation capabilities cover a variety of aspects. Many authors agree that first of all, innovation capabilities refer to an

organizational ability to introduce innovation outputs (Elmquist & Le Masson, 2009; Rangone, 1999; Lawson & Samson, 2001; Wang & Dass, 2017; Romijn & Albaladejo, 2002; Xu, Lin, & Lin, 2008; Koc, 2007; Neely et al., 2001; Saunila & Ukko 2012). However, on the one hand, some definitions highlight internal aspects of innovation capabilities, such as skills and knowledge, which are necessary to advance existing technologies (Romijn & Albaladejo, 2002); new idea generation (Wang & Dass, 2017), opportunity recognition, and resource combinations needed to develop recognized opportunities (Withers et al., 2011); and innovative cultures and internal promoting activities in organizations (Panayides, 2006; Akman & Yilmaz 2008). On the other hand, some definitions indicate external aspects of innovation capabilities: namely, external resources and competences (Elmquist & Le Masson, 2009). In this regard, according to the aforementioned definitions and Lawson and Samson's influential paper, innovation capabilities should be considered in terms of two types of aspects: *internal* and *external*.

### *2.2.1 Internal innovation capabilities.*

*Internal innovation capabilities* consist of core elements related to internal innovation processes that occur at different units of analysis (e.g., project or firm ): (1) internal innovative skills and competence development (Tan, Zhan, Ji, Ye, & Chang, 2015), (2) internal knowledge and learning processes (Elmquist & Le Masson, 2009), (3) internal communication and team-based work (Ribeiro-Soriano et al., 2010), (4) trial and error (experimentation) in innovation development (Eisenhardt & Martin, 2000), (5) idea recognition and resource orchestration (Duran et al., 2016; Withers et al., 2011), and (6) cultural and social linkages as well as cognitive frameworks (Parrilli & Heras, 2016).

First, *internal innovative skills and competences* are necessary to develop and advance existing technologies and innovative processes as well as to create new ones (Hogan, Soutar, McColl-Kennedy, & Sweeney, 2011) at different levels. At the project level, these skills and competences provide valuable insights in radical product development (e.g., McDermott and O'Connor (2002). At the firm level, internal organizational skills

and competences ensure firms can overcome diverse obstacles as well as develop and capitalize on innovation outputs that open up new business opportunities (Assink, 2006).

Second, *learning and transforming knowledge and ideas* into innovation outputs is the primary goal associated with innovation capabilities (Breznik & Hisrich, 2014). At the project level, the consolidation of project knowledge helps firms avoid repeating old mistakes and achieve successful project results (Hermano & Martín-Cruz, 2016). At the firm level, knowledge transfer and knowledge sharing across an organization as well as learning and interaction between departments and units within the organization facilitate innovation capabilities (Saunila et al., 2014).

Third, *internal communication and team-based work* mainly promote the development of internal innovation capabilities at the project and firm levels. Particularly, Molden and Clausen (2020) noted that internal innovation capabilities stem from internal team-based processes and heavily rely on general communication skills, for example, communication with colleagues from another culture. Panayides (2006) suggested that team-based processes that arise from relationship management, such as trust, communication, bonding, and shared values have an impact on the development of innovation capabilities. In other words, one of the driving forces of internal innovation capabilities is team members' communication capacity (in a project or organization), which ensures the effective mobilization, transformation, and transfer of their individual knowledge into organizational knowledge (Ribeiro-Soriano et al., 2010).

Fourth, *trial and error (experimentation)* in innovation development refers to intra-team and intra-organizational processes that facilitate internal innovative capabilities. Thus learning-by-doing activities, prototyping, and experimentation generate a common knowledge and experience base in a project or organization (Eisenhardt & Martin, 2000) that facilitates the delivery of internal innovation capabilities. For example, exploring the Volvo Cars project aimed at enhancing the company's capabilities, Börjesson and Elmquist, (2011) stated that the capability to innovate

directly relates to experiments with new solutions. They concluded that alternative approaches and experimenting (i.e., the ability to do things differently), such as experimenting with alternative methods and with idea generation, comprise the cognitive aspect of innovation capabilities. Moreover, in order to advance internal innovation capabilities, teams and organizations should be open to experimentation, not only when they develop new ideas but also when they implement new methods and approaches for innovation (Börjesson, Elmquist, & Hooge, 2014).

Fifth, *idea recognition and resource orchestration* are important processes that facilitate the delivery of innovation capabilities in terms of knowledge and resource accumulation and transformation for subsequent translation into innovation outputs (Withers et al., 2011). The idea-recognition process takes place at the individual, team/project, and firm levels and depends on the ability of a person, team, or organization to estimate the potential value of new knowledge (ibid). Resource orchestration, on the other hand, is inherent in a project's or an organization's ability to allocate necessary resources to develop innovative outputs (Duran et al., 2016)

Finally, *cultural and social linkages* as well as *cognitive frameworks* are important components of internal innovation capabilities at the meso and macro levels. Lawson and Samson (2001) stated that ambiguity tolerance, empowered employees, creativity, and information exchange (cross-functional, cross-hierarchical, cross-cultural, and cross-technological) are the main components underlying the organizational culture construct. Social linkages by means of intra-team/organizational information exchange enable the creation and diffusion of innovative solutions since continuous interaction facilitates information flow and the development of new ideas (Lin, Chen, & Chiu, 2010). A cognitive framework is determined by a project or organization team due to the need for continuous competence development without specifying or initially knowing how such development can be achieved (Börjesson, 2011).

### *2.2.2 External innovation capabilities.*

*External innovation capabilities* are related to the innovation processes outside a team, project, firm, or supply chain and include (1) collaboration and networking (Laursen & Salter, 2006), (2) external expertise (Mothe & Thi, 2010), and (3) open search (Molden & Clausen, 2020).

First, *collaboration* is a widely discussed topic in the innovation capabilities literature. Many authors have included collaboration in their research on innovation capabilities at the firm and supply-chain levels and have considered it in terms of inter-organizational cooperation in the form of joint ventures, networks, inter-organizational alliances, strategic alliances, consortia, partnerships, and cooperation within (and outside of) supply chains (Soosay et al., 2008). Some authors have considered collaboration at the firm level in terms of shared knowledge and learning (Figueiredo, 2010; Swink, 2006), emphasizing the type of knowledge (tacit and/or explicit) (Mohannak, 2007) that partners share and develop as a result of collaboration. Moreover, external collaboration, as an important element of innovation capabilities, can be considered in terms of the type of partner (business and scientific) and the ways partners contribute to the delivery of innovation capabilities (Björkdahl & Börjesson, 2011; Holtzman, 2014; Martínez-Román et al., 2011; Mohannak, 2007; Soosay et al., 2008). At the organization/region/country level, external collaboration, as a core element of innovation capabilities, could be investigated in terms of innovation modes originating from the wider literature on innovation systems (Jensen et al., 2007). Specifically, external collaboration could be examined in terms of the influence of (1) the mode focused on scientific and technologically based innovation (STI), which assumes that collaboration with scientific partners aims to generate codified and explicit knowledge, and (2) the mode focused on learning by doing, by using, and by interacting (DUI), which includes collaboration with business partners, the exchange of tacit knowledge (Parrilli & Heras, 2016), and their possible combined effect.

Second, *external expertise* facilitates the nurturing of external innovation capabilities and addresses when incorporated expertise from outside expands innovation capabilities at the project and firm levels. At the project level, project members sometimes need external expertise from “gurus” in a particular field/industry who are competent in a very narrow area to develop innovation capabilities within the team (Keegan & Turner, 2002). At the firm level, external innovation capabilities can be expanded through the acquisition of another company by incorporating the donor’s accumulated innovation capabilities into the recipient’s organization (Salvato, Lassini, & Wiklund, 2007).

Finally, *external search for new ideas* (i.e., *open search*) aims at harnessing a wide range of external actors and sources (Laursen & Salter, 2006) to recognize and develop innovative ideas and innovation capabilities. Commonly, open search strategies foster innovation development in projects and organizations by enabling engagement with external groups to support the cross-fertilization of new ideas that contribute to achieving win-win outcomes and developing innovation capabilities (Samson & Gloet, 2014).

Moreover, some authors have clarified the underlying processes and activities (e.g., knowledge and opportunity transformation) by which innovation capabilities enable the introduction of innovation outputs. Thus, given the complexity of organizational innovation capabilities and their relationship with innovation outputs, some researchers have called for investigating the phenomenon as multi-dimensional constructs, which are presented in Figure 2.1 below.

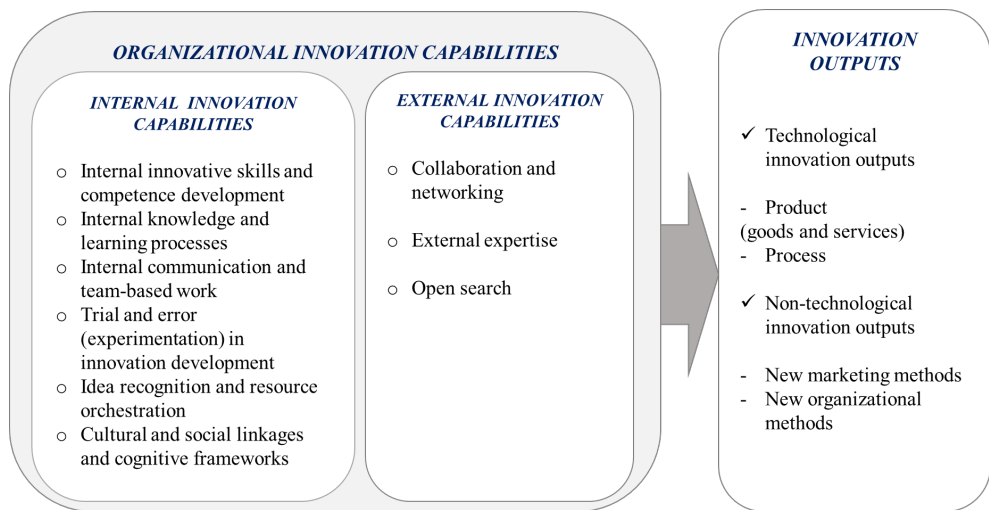


Figure 2.1 An integrative framework of organizational innovation capabilities and their relationship with innovation outputs.

Finally, a recent definition states that innovation capabilities are related to processes within and outside a firm (Molden & Clausen, 2020), suggesting a relevant contingency for examining the internal and external processes and activities related to innovation capabilities. Thus, I provide a formal definition of innovation capabilities based on the convergence among the definitions of innovation capabilities presented in the literature in recent years.

**Innovation capabilities refer to the capacity of an organization to continuously develop innovation outputs by means of underlying processes and activities that facilitate the transformation of internal and external resources, capabilities, and competencies into innovation outputs.**

## 2.3 Theoretical unresolved tensions and gaps relating to innovations and innovation capabilities

Innovation capabilities facilitate the introduction of *innovation outputs* by stimulating and enhancing the efficiency of the *innovation process*, thus enabling organizations to gain a competitive advantage. By *innovation process*, I consider the transformation of innovation inputs (e.g., R&D, financial investment) into innovation outputs. Whereas organizations differ both in their level of innovation inputs and in the process of transforming inputs into innovation outputs, innovation capabilities are aimed at enhancing innovation outputs (Duran et al., 2016). The extant empirical research (presented in Table 2.3 below) focuses on some specific aspects of the relationship between innovation capabilities and innovation outputs, revealing existing gaps in the extant literature.

Table 2.3 Empirical research on the relationship between innovation capabilities and innovation outputs.

Reference	Key Findings	Research Gaps and Avenues for Future Research
Molden & Clausen, 2020. "Playing 3D chess, or how firms can thrive under complexity: The mediating role of innovation capabilities in the use of innovation input"	The authors found that "firms that have developed such innovation capabilities are better at creating innovation output[s]" (p. 9) and identified two faces (internal and external) of innovation capabilities.	"A promising line for future research is to study whether and to what extent innovation capabilities have the same or different effects on different types of innovation" (p. 10).
Aniruddha & Mital, 2016. "Role of dynamic capabilities in innovation output of high-technology firms"	The authors concluded that innovation capabilities may contribute to the delivery of innovation outputs (product innovations in this study) if supported by absorptive capacity.	More research is needed to generalize the relationship between innovation capabilities and innovation outputs since the current study is limited to by its high-technology firm context and understanding of innovation outputs (as product innovations).



Romijn & Albaladejo, 2002. "Determinants of innovation capability in small electronics and software firms in southeast England"	The authors investigated the internal and external determinants of innovation capabilities and their implications for product innovations. The results confirmed the importance of internal determinants (R&D and proximity to suppliers), while the influence of external determinants (regional networks and close customer relationships) on product development were not confirmed.	More research is needed to understand the external determinants of innovation capabilities. In addition, innovation outputs are presented only as product innovations, which provides a basis for future research.
Martínez-Román, et al., 2011. "Analysis of innovation in SMEs using an innovative capability-based non-linear model: A study in the province of Seville (Spain)"	"The main contribution of this paper consists in proposing an interactive model based on innovative capability . . . and . . . explains the innovative outcomes of SMEs in all sectors" (p. 473).	This study is limited by ITS geographical (province of Seville, Spain) and firm size context, suggesting a gap to fill by future research on the relationship between innovation capabilities and innovation outputs in various sectors and geographical areas, in larger firms, and with diverse contextual factors.
Prajogo & Ahmed, 2006. "Relationships between innovation stimulus, innovation capacity, and innovation performance"	The main findings suggest that innovation capabilities should first be triggered by an innovation stimulus (behavioral and cultural innovative practices) to deliver better innovation outputs.	This research is focused on the organizational level, while more research is needed to understand which stimuli are important at other levels of analysis.
Saenz & Perez-Bouvier, 2014. "Interaction with external agents, innovation networks, and innovation capability: The case of Uruguayan software firms."	This study provides insights into collaborative processes, suggesting their positive influence on innovation capabilities and innovation outcomes (the generation of the new ideas).	The authors stressed that "many previous studies have proved the relevance of collaborative networks for innovation outputs and outcomes . . . , but not on the processes underlying innovation capability" (p. 463), which opens up fruitful avenues for further research on collaborative aspects of innovation capabilities.

The current innovation and strategic management literatures provide companies with broad and complex knowledge regarding how to perform successfully in today's dynamic environment (Breznik & Hisrich, 2014), and scholars have especially emphasized the importance of innovation outputs and innovation capabilities for firms' ability to maintain a competitive advantage over time (Lawson & Samson, 2001).

In this regard, Molden and Clausen (2020, p. 2) suggested that “the influence of an organization’s capacity for innovation (its innovation capability) on innovation as a process and innovation as an outcome . . . needs to be better understood.” In other words, we have limited understanding of the role of innovation capabilities in the development of innovative outputs, which may provide an answer for why certain business units differ in their ability to develop innovation outputs. In addition, Molden and Clausen (2020) suggested distinguishing between internal and external innovation capabilities because they affect the development of technological and non-technological innovative outputs in different ways, which may be influential both for practice and for future research in this area.

However, the research presented in Table 2.3 shows that the understanding of the relationship between innovation capabilities and innovation outputs is fragmented. First of all, research on the relationship between innovation capabilities and innovation outputs often focuses on a narrow technological context (e.g., investigating only innovation products as innovation outputs) (Aniruddha & Mital, 2016, Romijn & Albaladejo, 2002), thus omitting research on non-technological innovation outputs. Further, authors focus on particular contexts, such as organizational (Prajogo & Ahmed, 2006, Aniruddha & Mital, 2016) and inter-organizational processes (Saenz & Perez-Bouvier, 2014), size, and geography (Martínez-Román, et al., 2011). Thus, additional research on both technological and non-technological innovation outputs in a broader context would help generalize our knowledge to more fully understand the role of innovation capabilities in the development of innovation outputs. Finally, most research examines innovation capabilities at the firm level (Iddris, 2016), so more research needs to investigate how organizational innovation capabilities materialize at other levels (Iddris, 2016, Im et al., 2013, Prajogo & Ahmed, 2006).

### 3 Methodology

As Breznik and Hisrich (2014, p. 374) aptly put, “innovation capability is probably the most important capability a firm can have.” Although research on innovation capabilities has expanded significantly in recent years (Schilke et al., 2018), there is still a lack of consensus in the innovation management literature on how innovation capabilities influence innovation (Wang & Dass, 2017). To further advance knowledge on the relationship between organizational innovation capabilities and innovation outputs, which is the main research topic of this dissertation, I venture into a methodological discussion to clarify the ontological and epistemological assumptions of this study. Specifically, this chapter details the methodological approach I applied to explore my study’s research question. First, I discuss the philosophical foundations of this dissertation in terms of the ontological, epistemological, and methodological premises that form the basis of this study. Second, I present the research design of this dissertation, focusing on the methods and data. Finally, I describe the ethical issues that need to be considered in my research.

#### 3.1 Epistemological and ontological positioning

This research is inspired by a critical realist view. Critical realism appeared as an attempt to bridge the gap between positivism and constructivism (Jones & Gatrell, 2014) and was presented by British philosopher Roy Bhaskar (Danermark et al., 2002; Sayer, 2000). According to Fleetwood and Ackroyd (2004), critical realism relies on objective reality realized through individual perception and cognition, which implies that “reality must be subjected to the widest possible critical examination to facilitate apprehending reality as closely as possible (but never perfectly)” (Guba & Lincoln, 1994, p. 110). The critical realist ontology is “the way we think [about] the world” (Fleetwood, 2005, p. 197). Also known as the “nature of reality,” (Walsh & Evans, 2014) this ontology provides insights into knowledge about reality, which is quite complex to comprehend (Guba & Lincoln, 1994). At this point, the innovation capabilities phenomenon cannot be observed directly, so researchers study it through their

individual perception and cognition, which is in line with the critical realism view. Moreover, critical realism acknowledges that researchers receive, process, and respond to the same information differently, which causes debates among them because there is no criteria to determine the only “truth” (Easton, 2010). For instance, the extant literature on innovative capabilities is very complex and adopts different theories and reasoning approaches, which makes it impossible to achieve a single universal “truth.”

Thus, after reflecting on the assumptions about reality (ontology), I present the process of learning about reality (epistemology) (Adamides, Papachristos, & Pomonis, 2012). Critical realism comprises fallibilist epistemology, which means that “people cannot attain absolute certainty concerning questions of fact” (Peirce, 1955, p. 59). Further, “an epistemological issue for critical realists is associated with the domain of the deep structures, reflected in causal powers that shape agency actions that may not be observable” (Kempster & Parry, 2011, p. 111). This notion is consistent with my research on innovation capabilities because the phenomenon of organizational innovation capabilities is not directly observable, so research into these capabilities requires a different approach. To uncover the underlying processes that facilitate the relationship between organizational innovation capabilities and innovation outputs, I applied a quantitative approach to conceptualize and measure the aforementioned constructs (Edwards, 2011).

Both qualitative and quantitative methods (Johnson, Onwuegbuzie, & Turner, 2007) are conducive to critical realism, and the choice of method depends on the specific research (Sayer, 2000). Based on the information presented above, I present the methodology of this research, which comprises different quantitative techniques and combinations thereof for data collection and analysis to study reality (Healy & Perry, 2000). Using a set of different surveys, I conducted a statistical analysis of the role of innovation capabilities in the development of innovation outputs and the underlying processes in organizations. According to Edwards (2011, p. 382), “the

conceptualizations of constructs, measures, and causality underlying reflective measurement are consistent with a critical realist ontology of constructs.” Therefore, I implemented a methodological strategy to collect, measure, and analyze my data (see the research design chapter below) to answer the research question of this dissertation, which includes the following elements:

- (1) Processes and activities
- (2) Quantitative methods
- (3) Innovation capabilities as a complex phenomenon
- (4) Latent variables
- (5) Various data sources.

In other words, these elements allowed me to explore the role of innovation capabilities in the development of innovation outputs on the basis of existing theories. In particular, to gain a deeper understanding of the relationship between organizational innovation capabilities and innovation outputs, I investigated *activities* and *processes* (which occupy a key position in critical realism [Maxwell, 2012]) by developing causal explanations that capture the components of a social phenomenon in a stratified reality (Hoddy, 2019) and by applying quantitative methods, including, among others, mediator and moderator analyses. Taking into account the *complexity of the organizational innovation capabilities* phenomenon (which manifests in reflective *latent constructs* at different levels that cannot be directly observed), I used three different datasets and build my empirical research design to comprehensively explore the role of organizational innovation capabilities in the development of innovation outputs. I now provide more detail on the research design of this study.

## 3.2 Research design

My overall research question—*what is the role of organizational innovation capabilities in the development of innovation outputs?*—and sub-research questions determined the type of extensive research design I used to effectively address the

research problem of this study. I applied the extensive research design because it “address[es] regularities, common patterns, and distributions of features of populations” (Maxwell & Mittapalli, 2010, p. 155), which is consistent with the aim of this research. This research design relies on quantitative research methods (Sayer, 1992) and implies that the role of organizational innovation capabilities in the development of innovation outputs can be identified empirically, highlighting the significance of the sample choice, research question, and hypotheses (Lowe, 2001). I present the research design I used to answer my overall research question and uncover related innovation capabilities relationships in Table 3.1 below.

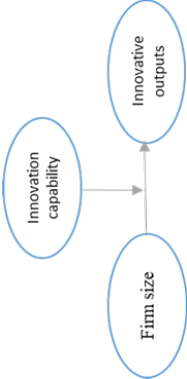
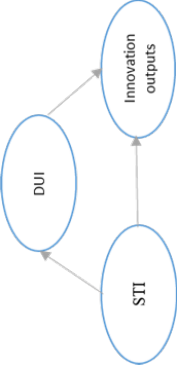
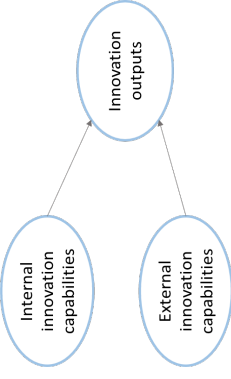
### *3.2.1 Unit of observation and analysis.*

Most of the existing literature on innovation capabilities focuses on the firm (macro) level (Iddris, 2016). This dissertation focuses on firms and projects, aiming to extend our understanding of how organizational innovation capabilities manifest at lower organizational levels. In this study, I argue that the fundamental innovation processes in an organization have a bottom-up origin such that processes of dynamic interaction between units at a lower level (i.e., project) lead to the organizational innovation capabilities phenomenon that yields innovation outputs at the organizational level over time (Kozlowski, Chao, Grand, Braun, & Kuljanin, 2013). This research relies on an indirect research approach, which is common for quantitative research, and assumes retrospective observations of projects and firms as the units of analysis (Kozlowski et al., 2013).

The quantitative indirect approach employed in this dissertation, which is summarized in Table 3.1, includes combinations of direct, mediation, and moderating effects and has some advantages and disadvantages (Kozlowski et al., 2013). In terms of the advantages of this approach, (1) it allowed me to summarize the data and support generalizations about phenomena related to innovation capabilities and innovation outputs and their relationships; (2) some observations of agents were made at two points in time, which enabled me to analyze relationships in time; and (3) the approach

relies on “a theoretical rationale for how the phenomenon at the lower level combines to manifest at the higher level” (Kozlowski et al., 2013, p. 588). However, the quantitative indirect approach has some disadvantages: (1) access to secondary data is sometimes limited, (2) there can be concerns about data practicality and feasibility (i.e., the researcher must ensure data sources are applicable for the given research problem (Hox & Boeijs, 2005), and (3) validity and sample representativeness can also be issues (questionnaires should ensure data validity, and the accuracy of results based on sample size and observed percentages can vary within the declared confidence limits).

Table 3.1 Research design of the research papers

Papers	Operationalization	Data Source	Relationships
<p><b>Paper 1</b></p>	<p>Innovation capabilities are explored in terms of internal processes at the firm level through the lens of two underlying processes—opportunity recognition and research orchestration—which lead to higher innovation outputs. Innovation capabilities are measured as a latent construct with items from the Innobarometer 2016 survey.</p>	<p><b>Innobarometer 2016:</b> Survey of innovation-related activities in the European Union, Switzerland and the United States. Wide coverage and tiered structure. Unit of analysis is the firm. Sample of 14,117 organizations.</p>	 <pre> graph LR     A(Firm size) --&gt; B(Innovation capability)     B --&gt; C(Innovative outputs)             </pre>
<p><b>Paper 2</b></p>	<p>Two external processes underlying innovation capabilities are explored at the firm level: the STI and DUI innovation modes. Both the STI and DUI innovation modes are measured as latent constructs with items from the Innobarometer 2009 survey.</p>	<p><b>Innobarometer 2009:</b> Survey of strategic trends in innovation in the European Union, Switzerland, and Norway. Wide coverage and tiered structure. Unit of analysis is the firm. Sample of 5,238 organizations.</p>	 <pre> graph LR     A(STI) --&gt; B(DUI)     B --&gt; C(Innovation outputs)             </pre>
<p><b>Paper 3</b></p>	<p>Innovation capabilities are considered in terms of both internal and external processes at the project level. Both internal and external innovation capabilities are measured as latent constructs using customized items from the User Survey 2010 conducted in Norway.</p>	<p><b>User Survey 2010:</b> Survey of projects' contributions to collaboration, competence development, innovation behavior, and actual innovation conducted in Norway. Panel data (repeated cross-sectional data at two points in time). Unit of analysis is the project. Sample of 1,888 firms.</p>	 <pre> graph LR     A(Internal innovation capabilities) --&gt; B(Innovation outputs)     C(External innovation capabilities) --&gt; B             </pre>



Papers	Key Constructs	Organizational Innovation capabilities	Innovation	Statistical Method
<b>Paper 1</b>	<p>Innovation capabilities: Innovation capabilities as opportunity recognition and research orchestration as moderators of innovation development.</p> <p>Innovation: Innovation outputs as types of innovations (i.e., good,</p>	<p>Innovation capabilities are measured as investments in targeted innovative activities using firms' responses to the following Innobarometer 2016 question:</p> <p>" What percentage of total turnover has your company invested in each of the following activities: software development; training; product and service design; organisation or business process improvements; acquisitions of machines, equipment, software, and licencing?"</p>	<p>Innovation as innovation outputs, which are measured using firms responses to an Innobarometer 2016 question asking whether they introduced any type of innovation (i.e., good, service, process, market strategy, or organizational method) since January 2013.</p>	<p>Multiple regression analysis; Baron and Kenny's (1986) moderation estimation</p>
<b>Paper 2</b>	<p>Innovation capabilities: Innovation capabilities through DUI and STI, where DUI substitutes STI in innovation development.</p> <p>Innovation: Technological and non-technological innovation outputs.</p>	<p>STI mode (as external innovation capabilities).</p> <p>STI mode is a latent variable, which is measured by separately coding each answer as 1 if the focal company collaborated with (1) educational institutions and/or (2) research institutes and 0 if the company did not.</p> <p>DUI mode (as external innovation capabilities) is a latent variable consisting of following items: external relationships with (1) customers or clients, (2) suppliers, and/or (3) other companies. Each answer is coded as 1 if the focal company internal and external innovation capabilities are measured as firms' responses to the following questions:</p> <p>Internal innovation capabilities:</p> <p>" To what extent does the project/activity contribute to the following innovation behavior:</p> <ol style="list-style-type: none"> <li>(1) Increased focus on development and innovation?</li> <li>(2) Better utilization of knowledge?</li> <li>(3) Competence development in myself/employees?"</li> </ol> <p>External innovation capabilities: " To what extent does the project/activity contribute to the following innovative behavior:</p> <ol style="list-style-type: none"> <li>(1) Hiring new employees?</li> <li>(2) Seeing new opportunities in international cooperation?</li> <li>(3) The development of collaboration/networks?"</li> </ol>	<p>Innovation as technological and non-technological innovation outputs.</p> <p>Technological innovation outputs are measured as firms' responses (a set of binary responses) to the question, " Did you achieve significantly improved or new (1) products, (2) processes, (3) services?"</p> <p>Non-technological innovation outputs are measured as firms' responses (a set of binary responses) to the question, " Did you achieve significantly improved or new (1) marketing strategy, and</p>	<p>Constructs estimated using latent response theory; fixed-effects and Bayesian causal mediation estimation</p>
<b>Paper 3</b>	<p>Innovation capabilities: Internal and external innovation capabilities, where the internal aspects are expressed through internal processes (developed competencies, learning, and experiments), and the external aspects stem from external sources (open search and external expertise).</p> <p>Innovation: Technological and non-technological innovation outputs.</p>	<p>Internal and external innovation capabilities are measured as firms' responses to the following questions:</p> <p>Internal innovation capabilities:</p> <p>" To what extent does the project/activity contribute to the following innovation behavior:</p> <ol style="list-style-type: none"> <li>(1) Increased focus on development and innovation?</li> <li>(2) Better utilization of knowledge?</li> <li>(3) Competence development in myself/employees?"</li> </ol> <p>External innovation capabilities: " To what extent does the project/activity contribute to the following innovative behavior:</p> <ol style="list-style-type: none"> <li>(1) Hiring new employees?</li> <li>(2) Seeing new opportunities in international cooperation?</li> <li>(3) The development of collaboration/networks?"</li> </ol>	<p>Innovation as technological and non-technological innovation outputs.</p> <p>Technological innovation outputs:</p> <p>" To what extent has the project/activity led to:</p> <ol style="list-style-type: none"> <li>(1) Improving the design, properties, and qualities of existing products?</li> <li>(2) The development of a new product?</li> <li>(3) The development of a new service?</li> <li>(4) The development of a new production process?"</li> </ol> <p>Non-technological innovation outputs:</p> <p>" To what extent has the project/activity led to:</p> <ol style="list-style-type: none"> <li>(1) The use of new sales channels or marketing methods?</li> <li>(2) The introduction of products/goods and/or services to new customer groups?</li> <li>(3) New methods for organizing work responsibilities and decisions within the company?</li> <li>(4) New methods for organizing external relationships with other companies or public institutions?"</li> </ol>	<p>Multiple regression analysis</p>

### *3.2.2 Data collection.*

Stemming from the extensive research design (Sayer, 1992), this thesis is based on secondary data (three separate databases: Innobarometer 2016, Innobarometer 2009, and User Survey 2010), which were primarily collected for different goals but were re-used to answer the overall research question of this study. Secondary data has both advantages and disadvantages. Some research, like this research, may benefit from using diverse datasets due to the complexity of the investigated phenomenon. In particular, secondary data (particularly surveys as data sources) ensure some advantages: (1) secondary data is more readily available, so more scientists can inspect and verify the research results (Calantone & Vickery, 2010), (2) secondary data provides the opportunity to quickly collect a broad number of repeated measures at different levels of analysis in large samples and over a wide area (Maula & Stam, 2020), and (3) secondary data opens up significant potential for exploring capabilities as it allows a wider range of econometric methods to be applied (Schilke et al., 2018).

Hence, I decided to use secondary data in this dissertation for three main reasons. First, this research was bound to a four-year period during which I expected to explore the role of innovation capabilities in the development of innovation outputs in organizations and projects. Due to the different units of analysis, data collection at the firm and project levels would have been a very time-consuming process; however, secondary sources made it possible for me to retrieve relevant data in a reasonable period of time. Thus, secondary data allowed me to achieve the research objective in the given time period. Second, to generalize the results, my research required a variety of data at the firm level (from different countries), but such data collection is very expensive and time consuming. In addition, I aimed to generalize the results among different countries in this dissertation, which necessitated knowledge of the different languages in Europe. Finally, the external validity and relevance of the datasets used in this dissertation have been proven in previous studies, which is an advantage of using these particular secondary sources.

Despite the obvious advantages of using secondary data, it has some limitations. Hox and Boeije (2005) identified several challenges that arise when working with secondary data, including methodological, data-quality, and practicality issues. One of the main issues with using secondary data is methodological as such data requires researchers to ensure the validity of responses and sample representativeness. Another issue is the need to evaluate the methodological quality of the data. In other words, researchers must check whether the focal interview questions were carefully designed and evaluated. For this purpose, a detailed description of the methods and data-collection algorithms are required (Hox & Boeije, 2005). Finally, researchers have to assess the practicality and feasibility of their secondary data, which requires convergence of the content and variables, narrative understanding, and availability of meta-information. As mentioned above, I used three different secondary datasets to answer the main research question of this dissertation, and my analysis of the suitability of each survey is presented below.

The **Innobarometer 2016** database, which my first paper is based on, is the result of the FLASH EUROBAROMETER 433 survey of innovation-related activities conducted at the request of the European Commission, with a final sample of 14,112 enterprises (Innobarometer, 2016). The methodological criteria of validity and sample representativeness that are usually applied for secondary data-quality evaluations are fulfilled. As mentioned, other issues that are crucial for the use of secondary data are data practicality and feasibility. In this regard, I built my search strategy based on the research problem, research theory, specific context, and variables used to test the posed hypotheses. The FLASH EUROBAROMETER 433 survey fulfilled these criteria since it covers the innovation field with a special focus on innovation types and innovativeness, which are the required concepts in my research. Moreover, the codified answers allowed me to build latent variables according to previous research. Consequently, the FLASH EUROBAROMETER 433 survey is an appropriate data source to partly answer the first sub-research question of this dissertation: SRQ1—what is the

role of internal organizational innovation capabilities in the development of innovation outputs?

My second paper is also based on secondary data, particularly on the **Innobarometer 2009** dataset. The main topic of the eighth wave of the Innobarometer survey was “strategic trends in innovation” in 2006–2008 (Innobarometer, 2009). Target companies operating in the 27 member states of the European Union, Switzerland, and Norway were selected for interviews. In total, 5,238 companies were interviewed. Innobarometer 2009 is a well-documented dataset, and I downloaded available descriptions of the methods and routines for data collection and coding from the official data archive (Hox & Boeije, 2005). The methodological criteria of validity and sample representativeness are fulfilled. Innobarometer 2009 also meets the criteria for practicality and feasibility. The data corresponds to the topic of the second paper, enabling me to connect innovation, national innovation systems, and innovation capabilities with the variables from the dataset. The dataset fits the posed hypotheses and allowed me to answer the second sub-research question of this dissertation: SRQ2—what is the role of external organizational innovation capabilities in the development of innovation outputs?

The **User Survey 2010** (Kundeeffektundersøkelsen), which my third paper is based on, is a customer impact survey at the project level that was conducted in Norway among the firms that receive governmental support for innovation development. Organizations that participated in the preliminary survey were also interviewed in a follow-up survey. The final sample used for this study contains 1,888 projects. The methodological criteria of validity and sample representativeness are fulfilled (the measurement factors are controlled by an exploratory factor analysis on the scale items.). The survey contains a set of questions suitable for measuring the latent construct of innovation capabilities and clearly indicates the internal and external aspects of innovation capabilities as well as distinguishes between the technological and non-technological innovation outputs that were generated at the end of the

innovative projects. Thus, the survey meets the criteria of practicality and feasibility. This dataset is well suited for answering the third sub-research question of this dissertation: SRQ3— to what extent do both internal and external organizational innovation capabilities contribute to the development of innovation outputs in projects?

In sum, the Innobarometer 2009 and Innobarometer 2016 databases have similar data-collection techniques, and both contribute to answering the overall research question with the firm as the unit of analysis. The data-collection techniques of the User Survey 2010 are quite similar to those of the Innobarometer 2009 and Innobarometer 2016 surveys (all data was collected using questionnaires) but differ from them in that the data was collected at two points in time, which compensates for the disadvantages of using cross-sectional data. In particular, the User Survey 2010 data made it possible to track changes in innovation capabilities and also contributed to answering the overall question of this dissertation, having the project as the unit of analysis. The connecting link between all this data is the analysis of innovation outputs and innovation capabilities, which manifest at the project and firm levels. Thus, all three datasets contributed to answering the overall research question and sub-research questions of this dissertation.

### *3.2.3 Data sources.*

Since the overall research question includes three sub-research questions and covers both internal and external aspects of innovation capabilities, I searched for several data sources. First, I chose the Innobarometer 2009 and Innobarometer 2016 datasets to study internal and external innovation capabilities and the underlying processes with the firm as the unit of analysis. Then, I chose the User Survey 2010 dataset to explore internal and external innovation capabilities with the project as the unit of analysis. Hence, each of the three papers of this dissertation is based on a separate dataset. My choice of statistical methods and analytical tools was based on the data structure and research objectives of each paper. The analyses for Papers 1 and 3 were accomplished

with the SPSS statistical software, while the analysis for Paper 2 was accomplished with the R-statistical software. In addition, some of the results were cross-validated by checking them using the SmartPLS software (partial least square structural equation model [PLS-SEM]). The choice to use this method is optional for the critical realism position, which suggests using quantitative methods when appropriate (Johnson et al., 2007), so I adopted the quantitative approach since this dissertation focuses on (1) uncovering the main processes and activities, (2) examining them by means of reflective latent measurement, and (3) using advanced econometric techniques.

#### *3.2.4 Data-analysis strategy.*

All three papers have the same analysis strategy. First, the data was screened, cleaned, prepared, and limited to the variables capturing the focal constructs. In this dissertation, many variables are ordinal in nature, and I also employed Likert scales expressing respondents' attitudes or opinions about certain statements, which are commonly used in research based on questionnaires. These variables are associated with latent constructs relevant to my research, such as innovation capabilities (internal and external); innovation outputs (technological and non-technological); the doing, using, and interacting (DUI) and science, technology, and innovation (STI) innovation modes, etc. Due to the complex structure of many variables in this dissertation, I employed dimension-reduction techniques (Pallant, 2013) to develop and test some key concepts: (1) *confirmatory factor analysis*, which was used to reduce the dimensionality of the items and questions, and (2) *item response theory*.

Second, my choice of estimation method for each paper was driven by the relationships between the core constructs, the underlying processes, and the structure of the data (cross-sectional and time-series data) since my dissertation employed data from different geographical areas and years. Papers 1 and 3 employed ordinary least squares regression applied as a multiple linear regression technique (Pallant, 2013). In addition, Paper 1 used the Baron and Kenny approach to confirm the moderation effect (Baron & Kenny, 1986). I chose these estimation methods for Papers 1 and 3 since I

aimed to reveal whether innovation capabilities affect the strength of the relationship between the liability of smallness and innovation (Paper 1) and to determine the strength of the relationship between organizational innovation capabilities and innovation outputs (Paper 3). Paper 2 utilized *causal mediation analysis* with bootstrapped standard errors applying a quasi-Bayesian estimation (Tingley et al., 2014). This method was chosen because, in addition to causal effects estimation, I aimed to comprehend the mediating process by which capabilities causally affect innovation outputs (Tingley et al., 2014). Moreover, to control for fixed factors, such as sector or country, I applied fixed-effects estimations.

### *3.2.5 Validity and reliability of the research.*

To ensure the quality of my research I have paid attention on validity and reliability of my measurements and constructions. Validity refers to whether “an instrument actually measures what it sets out to measure” (Field, 2013, p. 12), while reliability refers to “whether an instrument can be interpreted consistently across different situations” (ibid).

To ensure the internal validity of my research (i.e., to be sure that the tested causal relationships are trustworthy), I used a wide range of factors or variables based on previous research on innovation. Moreover, external validity (or generalizability) refers to the degree to which research results can be applied to other context (Somekh & Lewin, 2005) and can be ensured by using large samples, as I did in Papers 1 and 2.

One aspect of construct validity—historical validity—is necessary “in making decisions about the value of a study’s inferences (as well as its design, measures and methodologies)” (Dellinger, 2005, p. 44). Historical validity accumulates as a result of the use and citation of research from the existing literature and is especially relevant for novice researchers (ibid). Although the innovation capabilities literature provides heterogeneous definitions of innovation, I developed clear construct definitions of the focal constructs and made sure all the indicators I used reflect their underlying constructs (Maula & Stam, 2020), which ensured the construct validity of my study. In

addition, construct validity was measured for the latent variables, which is important when working with phenomena that cannot be directly observed (like innovation capabilities). Other aspects of construct validity are convergent and discriminant validity. Convergent validity “is the extent to which the construct converges to explain the variance of its items” (Hair, Risher, Sarstedt, & Ringle, 2019, p. 9), while discriminant validity “is the extent to which a construct is empirically distinct from other constructs in the structural model” (Hair et al., 2019, p. 9). In my dissertation, I validated the correspondence between items for each construct and checked that the constructs are conceptually distinct (Henseler, Ringle, & Sarstedt, 2015).

When it comes to the reliability of my study, I paid special attention to internal consistency. Internal consistency “is the degree to which items that make up the scale are all measuring the same underlying attribute” (Pallant, 2013, p. 6). I relied on previous research and used previous approaches to measure the latent constructs, including innovation capabilities. However, the challenge is that a uniform approach for measuring this phenomenon does not exist due to different understandings of this concept in the literature. Hence, I combined several dimensions into one variable to increase the reliability, which was also verified from the statistical viewpoint. The methods I chose for testing the proposed focal concepts and underlying processes have some strengths and limitations. The strengths of the applied methods are they (1) enable unobserved heterogeneity to be addressed, (2) ensure causal inference, and (3) explain changes (Maula & Stam, 2020). The limitations are (1) regression methods uncover only linear relationships, and (2) a large dataset is needed to get reliable results (Pallant, 2013).

### **3.3 Ethical considerations**

To achieve objective and accurate results, I implemented guidance on the ethics of quantitative research offered by Ringdal (2001). Ringdal focused on a responsible research process, attention to privacy, proper use of the findings, and a reasonable research driving force. The current research makes use of secondary data that includes



some private data. Norwegian legislation sets strict requirements for the safe storage of personal information and other data, which enables researchers to identify legal entities and individuals (Hvinden et al., 2016). Since I had to store such information in my research, I took appropriate actions to fulfill the associated demands. First, all datasets are stored securely and separately from other research materials (data). Second, the data that I downloaded for analysis was anonymized (or de-identified) (Peloquin, DiMaio, Bierer, & Barnes, 2020). Third, data with personal information (e.g., contact information) is protected by a two-level password for reading and activation. Fourth, all my research materials are inaccessible to unauthorized persons. Finally, the results are presented as a summary of each dataset, which ensures anonymity.

To ensure high-quality research, significant attention should be paid to credibility and ethics. According to Tracy (2010), procedural, situational, relational, and exiting ethics have a huge impact on research quality and the communities in which researchers work and live. Procedural, or categorical, ethics concern “big bodies,” such as universities, governmental organizations, and other institutions. Procedural ethics aim to avoid harm, fraud, or injury that can be caused by such institutions’ policies, claims, or actions. Based on the fact that this research project offers research results on behalf of Nord University, the main focus is on the accuracy, reliability, and high quality of the data.



## 4 Summary of the research papers

This chapter presents summaries of the research papers in this dissertation. In particular, I briefly discuss the papers' research questions, theoretical and methodological considerations, and key findings. All three articles are empirical and based on the data introduced in the previous chapter. An overview of the research papers is provided in Table 4.1.

Table 4.1 Overview of the research papers

Papers	Authors	Research Question(s) in the Papers	Theoretical Perspective	Focus	Publication Status
<b>Paper 1</b>	<b>Maryna Vakulenko</b>	To what extent do innovation capabilities enable companies to generate more innovative outputs and overcome the liability of smallness?	RBV	Manifestation of internal innovation capabilities at the firm level	Published. Technology Analysis & Strategic Management
<b>Paper 2</b>	<b>Maryna Vakulenko, Lars Hovdan Molden, Tommy Høyvarde Clausen, and Siri Jakobsen</b>	To what extent does DUI collaboration mediate STI collaboration's influence on technological and non-technological innovation?	DC	Manifestation of external innovation capabilities at the firm level	Revise and Resubmit. Technovation
<b>Paper 3</b>	<b>Maryna Vakulenko and Tommy Høyvarde Clausen</b>	What is the role of organizational innovation capabilities in innovation at the project level?	DC	Manifestation of internal and external innovation capabilities at the project level	In review. International Journal of Technology Management

## 4.1 Paper 1—The moderating role of innovation capability in the relationship between the liability of smallness and innovative outputs

Author: Maryna Vakulenko

Status: *Published—Technology Analysis & Strategic Management*

### *4.1.1 Introduction and research question.*

The extant literature discusses the role of innovation capabilities as an important factor that influences the development of innovation outputs (Lawson & Samson, 2001; Withers et al., 2011). However, understanding of their role and context is limited (ibid). To address this research gap, this study asks the following research question:

*To what extent do innovation capabilities enable companies to generate more innovative outputs and overcome the liability of smallness?*

### *4.1.2 Theoretical perspective*

This study discusses the role of innovation capabilities in small companies' ability to overcome the liability of smallness and develop innovative outputs. This study focuses on innovation capabilities in terms of the resource-based view (RBV) (Breznik & Hisrich, 2014) for companies that may be subject to the liability of smallness (Abatecola et al., 2012). The paper argues that to overcome the liability of smallness, organizations should develop their innovation capability by means of underlying *recognition* (Withers et al., 2011) and *orchestration* (Duran et al., 2016) processes, which constitute firms' innovation capability and further contribute to the development of innovative outputs. The paper suggests that small companies may develop more innovation outputs if they are able to recognize a reasonable number of new ideas (Chandy et al., 2006) and allocate available resources efficiently (Duran et al., 2016). Opportunity recognition and resource orchestration embody internal processes related to innovation capability that influence the development of innovation outputs in organizations. In other words, I argue that small companies are able to develop innovation outputs when they

develop and apply innovation capabilities, which helps them overcome the liability of smallness.

#### *4.1.3 Methods*

In this study, I employed a quantitative approach (multiple regression and moderation analyses) to analyze the secondary dataset and test the posed hypotheses. This study is based on the Innobarometer 2016 survey, which contains information on innovation-related activities from 14,112 organizations operating in the European Union, Switzerland, and the United States. In this study, the dependent variable is innovative outputs, the independent variable is firm size, and innovation capability is a moderator.

#### *4.1.4 Key findings*

This study aims to reveal how internal innovation capabilities enhance small companies' ability to develop innovation outputs and overcome the liability of smallness with regard to their internal complexity. Particularly, the findings contribute to better understanding the role of innovation capabilities as a moderator in the firm size–innovation output relationship. The results suggest that firms' innovation capabilities, which are embodied in the recognition and orchestration processes, are important for overcoming the liability of smallness and that smaller companies have a greater payoff from innovation capabilities.

## 4.2 Paper 2—The interplay between STI and DUI collaboration modes: Towards a more nuanced understanding

Authors: Maryna Vakulenko, Lars Hovdan Molden, Tommy Høyvarde Clausen, and Siri Jakobsen

Status: *Revise and Resubmit—Technovation*

### 4.2.1 Introduction and research question

This study focuses on how the underlying processes of scientific (science, technology, and innovation [STI] mode) and business (doing, using, and interacting [DUI] mode) collaboration (which can be regarded as manifestations of external innovation capabilities) contribute to the development of technological and non-technological innovation outputs at the firm level. Based on recent research stating that DUI and STI are substitutes in the innovation process, this study instead assumes that DUI is a necessary pre-condition for executing STI. In this regard, this study asks the following research question:

*To what extent does DUI collaboration mediate STI collaboration's influence on technological and non-technological innovation?*

### 4.2.2 Theoretical perspective

Extant theory suggests that dynamic capabilities stem from diverse strategic and organizational processes, such as alliancing processes, which provide access to external (outside the firm) knowledge (Eisenhardt & Martin, 2000). Hence, collaboration and knowledge are two important perspectives for studying external innovation capabilities, which are embodied in innovation models. This paper draws on the innovation modes literature, which sheds light on how scientific (STI mode) and business (DUI mode) collaboration enable firms to gain explicit and tacit knowledge (Apanasovich, 2016; Isaksen & Karlsen, 2010; Jensen et al., 2007). Recent research on innovation modes states that the DUI and STI innovation modes are substitutes (Haus-Reve et al., 2019) in the innovation process and suggests that the simultaneous

application of both modes does not ensure additional benefits in the development of innovation outcomes. Hence, this study focuses on how the STI-DUI interplay pans out, investigating which mode (STI or DUI) is the main source of firm heterogeneity and how the interplay contributes to the development of technological and non-technological innovation outputs.

#### *4.2.3 Methods*

In this study, we employed a quantitative approach (particularly fixed effects and Bayesian causal mediation estimation) to analyze the secondary dataset—namely, the 2009 Innobarometer Survey, which includes a sample of 5,238 firms across 29 countries. To construct coherent variables, this study relies on latent response theory since the main constructs of the study, including STI, DUI, and technological and non-technological innovation outputs, can be thought of as latent constructs.

#### *4.2.4 Key findings*

The paper extends knowledge about scientific (STI) and business (DUI) innovation modes (Apanasovich, 2016; Jensen et al., 2007) and generalizes the results across Europe by providing a comprehensive analysis of the mediation effects, which reveal that DUI is a necessary pre-condition for executing STI. The findings suggest that the DUI and STI modes substitute for each other, while previous research (Apanasovich, 2016; Jensen et al., 2007) suggests that these innovation modes are complementary to each other. Thus, this paper clarifies the role of scientific and business collaboration (as manifestations of external innovation capabilities at the firm level) in the development of innovation outputs.



## 4.3 Paper 3—Innovation at the project level: The role of organizational innovation capabilities

Authors: Maryna Vakulenko and Tommy Høyvarde Clausen

Status: *In review—International Journal of Technology Management*

### 4.3.1 *Introduction and research question*

Scholars have discussed the role of innovation capabilities as an important factor in explaining innovation outcomes (Guan & Ma, 2003; Sher & Yang, 2005; Strønen et al., 2017). However, the manifestation of innovation capabilities at the project level (Börjesson & Elmquist, 2011; Elmquist & Le Masson, 2009) as well as their internal and external aspects (Molden & Clausen, 2020) are still poorly understood. Therefore, this study addresses this gap in knowledge by asking the following research question:

*What is the role of organizational innovation capabilities in innovation at the project level?*

### 4.3.2 *Theoretical perspective*

This study builds on dynamic capabilities theory (Teece et al., 1997) and investigates to what extent two aspects of innovation capabilities (internal and external) (Molden & Clausen, 2020) manifest at the project level in terms of the development of innovation outputs. Particularly, this study theorizes about both internal and external innovation capabilities, the underlying processes during innovation projects, and in which way they affect the technological and non-technological innovation outputs of projects. In this paper, I test internal innovation capabilities as represented by (1) *internally developed competencies* (Molden & Clausen, 2020; Teece, 2007), (2) *systematic internal learning and knowledge application* (Zollo & Winter, 2002), and (3) *trial and error (experiments)* in innovation development (Eisenhardt & Martin, 2000). Further, I test external innovation capabilities developed through (1) *open search* (e.g., domestic and international networking) (Laursen & Salter, 2006; Molden & Clausen, 2020) and (2) *external expertise* (Mothe & Thi, 2010).

### *4.3.3 Methods*

In this paper, I used the secondary data from the User Survey 2010 (Kunderundersøkelsen, 2010) conducted in Norway at two points in time ( $T_1 = 2010$  and  $T_2 = 2014$ ), which explores innovative projects/activities during a four-year period. The final sample contains 1,888 projects. Ordinary least squares regression (particularly multiple regression) was applied to test the posed hypotheses.

### *4.3.4 Key findings*

This study fills a gap in the innovation literature by revealing how innovation capabilities manifest at the project level in the short term and clarifies the role internal and external innovation capabilities play in the development of technological and non-technological innovation outputs. The article suggests that both internal and external innovation capabilities are important for innovation output development in projects.

## 5 Conclusions and implications

This chapter presents the main findings and contributions of my research on the role of organizational innovation capabilities in the development of innovation outputs. The chapter begins by discussing how my work contributes to answering the three sub-research questions of this dissertation. Then, I present the academic and practical implications of this study. Finally, I provide an overview of the limitations and suggestions for further research.

### 5.1 Discussion of the research questions

Drawing on the debate about the role of innovation capabilities in the development of innovation outputs (Molden & Clausen, 2020), I introduced three sub-research questions in the first chapter of this dissertation. The sub-research questions concern two types of aspects of innovation capabilities—namely, internal and external—and their effect on the development of innovation outputs. The internal aspects of innovation capabilities focus on the internal activities involved in the development of innovation outputs, while the external aspects focus on the outside activities that contribute to the development of innovation outputs. Together, the sub-research questions embodied in my three research papers shed light on the overall research question of this dissertation asking about the role of organizational innovation capabilities in the development of innovation outputs.

#### *5.1.1 SRQ1: The role of internal organizational innovation capabilities in the development of innovation outputs.*

Organizations' internal innovation capabilities are a set of specific in-house processes (Eisenhardt & Martin, 2000), such as opportunity recognition (Withers et al., 2011), resource orchestration (Duran et al., 2016), internal competence development (Teece, 2007), internal learning (Zollo & Winter, 2002), and experiments (Eisenhardt & Martin, 2000). Since, internal innovation capabilities manifest in various distinct processes and at different levels, this dissertation employs dynamic capabilities and the resource-

based view (RBV) as the theoretical grounds. The RBV provides a framework to study internal innovation capabilities since “this perspective focuses on the internal organization of firms” (Eisenhardt & Martin, 2000, p. 1105) and to explain the relationship between innovation capabilities and innovation outputs in terms of resource and capability configurations. In this regard, Paper 1 contributes to SRQ1 by revealing the role of innovation capabilities expressed in internal opportunity recognition and resource orchestration processes through the lens of the RBV. Particularly, relying on the RBV, Paper 1 reflects the internal aspects of organizational innovation capabilities and their moderating role in the development of innovation outputs.

Paper 3 dimensionalizes internal innovation capabilities based on firms’ (1) *internal competency development* (Molden & Clausen, 2020; Teece, 2007), (2) *systematic internal learning and knowledge application* (Zollo & Winter, 2002), and (3) *trial and error (experiments)* in innovation development (Eisenhardt & Martin, 2000). Thus, Paper 3 reveals internal activities within companies (i.e., in projects) and emphasizes the importance of internal innovation capabilities for firms’ ability to develop technological and non-technological innovation outputs.

### *5.1.2 SRQ2: The role of external organizational innovation capabilities in the development of innovation outputs.*

This sub-research question relies on insights from the dynamic capabilities perspective, whereby external innovation capabilities are dimensionalized according to processes/activities outside organizations (Eisenhardt & Martin, 2000; Lawson & Samson, 2001; Schilke et al., 2018). In this regard, organizations’ external innovation capabilities are a set of specific processes outside of organizations: (1) *open search* (e.g., domestic and international networking) (Laursen & Salter, 2006; Molden & Clausen, 2020), (2) *external expertise* (Mothe & Thi, 2010), and (3) *scientific and business collaboration and knowledge acquisition* (embodied as the doing, using, and interacting [DUI] and science, technology, and innovation [STI] innovation modes and

as transactive memory systems) (Apanasovich, 2016; Haus-Reve et al., 2019; Isaksen & Karlsen, 2010; Jensen et al., 2007; Lewis & Herndon, 2011).

In this regard, Paper 2 contributes to SRQ2 by exploring the role of scientific and business collaboration and knowledge acquisition as external dimensions of innovation capabilities that may influence the development of both technological and non-technological innovation outputs. In particular, Paper 2 is based on the dynamic capabilities view and studies the underlying processes of innovation capabilities in their external context. Since external knowledge acquisition and collaboration are both dimensionalized as important processes outside an organization (Schilke et al., 2018), Paper 2 employs the concept of innovation modes because it represents the synthesis of scientific and business collaboration, both of which benefit firms by enabling them to obtain external tacit and explicit knowledge (Apanasovich, 2016; Isaksen & Karlsen, 2010; Jensen et al., 2007). Thus, Paper 2 contributes to SRQ2 by revealing the role of external innovation capabilities as expressed in the STI and DUI modes and their influence on the development of innovation outputs at the organizational level.

Paper 3 partly contributes to SRQ2 by investigating some external dimensions of innovation capabilities, including (1) open search (e.g., domestic and international networking) (Laursen & Salter, 2006; Molden & Clausen, 2020) and (2) external expertise (Mothe & Thi, 2010), in terms of their influence on the development of innovation outputs. In particular, Paper 3 clarifies the role of external innovation capabilities in projects, suggesting that external innovation capabilities facilitate the development of both technological and non-technological innovation outputs.

### *5.1.3 SRQ3: The extent to which internal and external organizational innovation capabilities contribute to the development of innovation outputs in projects.*

The prior literature argues that innovation capabilities in organizations generally promote effective innovation development (Lawson & Samson, 2001). However, considering both the internal and external aspects of innovation capabilities, some

researchers have questioned their role in the development of innovation outputs at lower levels of analysis (e.g., in projects) (Molden & Clausen, 2020). In this regard, SRQ3 clarifies the extent to which internal and external organizational innovation capabilities contribute to the development of technological and non-technological innovation outputs in projects within organizations.

Thus, Paper 3 sheds light on the role of internal and external innovation capabilities in the development of technological and non-technological innovation outputs at the project level. The results suggest that internal and external innovation capabilities are more beneficial for developing technological innovation outputs than for developing non-technological innovation outputs. Moreover, firms that develop their internal and external innovation capabilities are able to generate more solid technological and non-technological innovation outputs at the end of projects than firms that do not advance these capabilities.

#### *5.1.4 The role of organizational innovation capabilities in the development of innovation outputs.*

There are two aspects of innovation capabilities (internal and external) (Molden & Clausen, 2020) that help reveal the activities underlying the role of organizational innovation capabilities in the development of innovation outputs. On the one hand, internal innovation capabilities that enable organizations to develop innovation outputs that apply and modify their resource bases can be enhanced by in-house processes and activities. Through these distinct processes and activities, innovation capabilities manifest at different levels. First, at the firm level, organizations modify the composition and configuration of their existing capabilities through opportunity recognition (Withers et al., 2011) and resource orchestration (Duran et al., 2016), thus stimulating the development of innovation outputs. At the lower project level, internal innovation capabilities manifest as internal competency development (Tece, 2007), internal learning (Zollo & Winter, 2002), and experiments (Eisenhardt & Martin, 2000). In addition, the ability of some organizational bodies (e.g., innovation projects) to

develop innovation outputs in the short term has very important implications for organizations' overall ability to develop innovation outputs and exploit them.

On the other hand, external innovation capabilities stimulate the development of innovation outputs through processes and activities that go beyond the boundaries of an organization at different levels. First, at the firm level, external innovation capabilities manifest through scientific and business collaboration that enrich organizations with explicit and tacit knowledge (Apanasovich, 2016; Jensen et al., 2007), thus stimulating the development of innovation outputs. Second, at the project level, external innovation capabilities are embodied in processes and activities involving (1) external expertise (Mothe & Thi, 2010) and (2) open search (e.g., domestic and international networking) (Laursen & Salter, 2006; Molden & Clausen, 2020). These activities open up new horizons for organizations, expanding the knowledge of teams who run projects about "unknown unknowns" and thereby stimulating the development of innovation outputs.

Summing up, this research studied the underlying processes and activities of innovation capabilities whereby business bodies (firms and projects) can develop innovation outputs. In this regard, this dissertation has some contributions and implications, which I discuss in the following section.

## 5.2 Contributions and implications of the dissertation

This dissertation aims at illuminating the role of organizational innovation capabilities in the development of innovation outputs. In addition, this dissertation delivers findings that reveal the relationship between innovation capabilities and innovation outputs, providing some implications in two directions: (1) theoretical implications for the innovation management literature and (2) practical implications.

The current innovation management literature provides extensive knowledge about the role of innovation in achieving and maintaining a competitive advantage (Breznik & Hisrich, 2014; Lawson & Samson, 2001; Wang & Ahmed, 2004). However, we need

more research that pays closer attention to the role of innovation capabilities in the development of innovation outputs (Molden & Clausen, 2020). Answering this call, this dissertation develops a better understanding of innovation capabilities that reflects the internal and external aspects of these capabilities in organizations. Moreover, this study enhances the current state of knowledge on both innovation and innovation capabilities by separating the concept of innovation capabilities from the phenomenon of innovation (outputs) (Kahn, 2018). Thus, both the innovation capabilities and innovation (outputs) phenomena have been empirically investigated, and I found evidence that innovation capabilities contribute to the development of innovation (outputs) in projects and organizations.

Finally, this dissertation provides some practical contributions and facilitates better understanding of innovation capabilities' role in the development of innovation outputs through different processes and activities. I consider this an important topic because cultivating innovative capabilities is costly and time consuming, and managers should pay more attention to innovative capabilities in their organizations if they want to have better control over the development of innovation (outputs). In particular, the suggested understanding of innovation capabilities may guide decision makers on which innovation capabilities (internal or external) would be more beneficial for their companies in particular contexts and which innovation activities should be carried out to convert available resources and capabilities into innovation outputs. As a result, by applying the suggested understanding of innovation capabilities, decision makers have the opportunity to create unique formulas for increasing the innovativeness of particular organizational units (projects or/and overall organizations), which in turn increases their chances of developing more innovation outputs.

### **5.3 Limitations and suggestions for further research**

This dissertation provides a better understanding of organizational innovation capabilities' role in the development of innovation outputs. This section identifies limitations of this study as well as suggests future research avenues .



From a theoretical perspective, limitations arise from the theories and concepts that were employed to build the innovation capabilities phenomenon. In particular, the suggested dimensionalization of innovation capabilities (i.e., the items measuring innovation capabilities) is not comprehensive and may be enriched by searching for other dimensions from managerial, team, and firm perspectives. In addition, the framework can be complemented with antecedents, moderators, mechanisms, and consequences, which will enrich our understanding of innovation capabilities' role in the development of innovation outputs. Finally, the innovation capabilities concept pertains to specific processes, activities, and contexts in which these capabilities are applied. In this regard, future research may focus on particular contexts (e.g., industry and geography), which will advance our understanding of the innovation capabilities concept.

From a methodological perspective, key limitations arise from the cross-sectional data that was used in two papers of this study. Despite the theoretical evidence supporting the suggested relationships between the independent and dependent variables, future research may employ longitudinal quantitative methods to study the dynamic processes that underly innovation capabilities and how they change over time. Moreover, the quantitative methods that were employed for the purpose of this research may cause some limitations by themselves, particularly in explaining "how" and "why" issues. In this regard, qualitative research and mixed-methods research may be beneficial for gaining a deeper understanding of how internal and external innovation capabilities manifest at different levels and their role in the development of innovation outputs.



## 6 Dissertation papers

### 6.1 Paper 1

#### **The moderating role of innovation capability in the relationship between the liability of smallness and innovative outputs**

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Status: Published – Technology Analysis and Strategic Management

#### *Abstract*

Both small and large companies aim to develop innovative outputs to gain competitive advantages. However, large companies have advantages over small companies because of their human and financial resources, while small companies may suffer from the liability of smallness. At the same time, there are many examples when small companies successfully produce innovations using their innovation capability, which allows them to develop more innovative outputs. In this article, I explore how innovation capability influences companies' ability to produce innovative outputs depending on their size. The findings suggest that small companies could have a higher pay off from innovation capability, which stimulates higher innovative outputs and allows small companies to overcome the liability of smallness.

*Keywords:* innovation capability; innovative outputs; liability of smallness; opportunity recognition; resource orchestration

#### *6.1.1 Introduction.*

Firms' ability to convert available resources into innovative outputs is a fundamental aspect of firm competitiveness and growth (Chandy et al., 2006). However, firms vary in their ability to deliver innovative outputs due to differences in their size (Spescha, 2018) and innovation capability (Saunila & Ukko, 2014). In terms of firm size, large companies may have competitive advantages over small companies (Cabral & Mata, 2003; Schumpeter, 1950), which often suffer from the liability of smallness due to a

shortage of human and financial resources (Abatecola, Cafferata, & Poggesi, 2012). Regardless of their size, however, companies can still efficiently convert inputs into innovative outputs (Wakasugi & Koyata, 1997) if they are able to employ their innovation capability.

Since technological progress is driven by a continuous race between companies seeking to transform their resources into innovations, companies' success in delivering innovative outputs signals the effectiveness of their innovation development (Chandy et al., 2006). However, the development of innovative outputs does not occur all at once; rather, it is divided into several stages driven by distinct processes and requires opportunity recognition, considerable resources, and reasonable and efficient resource allocation to implement innovation activities (Withers, Drnevich, & Marino, 2011). Despite the centrality of innovation in firm-level entrepreneurship (e.g. Kuratko, Covin, & Garrett, 2009; Zahra, Nielsen, & Bogner, 1999), we have a limited understanding of why companies differ in their ability to successfully develop innovative outputs. In particular, there is a lack of research on how innovation capability enables the innovative outputs development (Withers et al., 2011) that may explain why companies differ in their ability to turn certain inputs into successful innovative outputs. Therefore, in this study, I examine innovation capability that explains why both small and large companies are able to develop innovative outputs, which have recently been identified as a crucial aspect of firm success (Duran et al., 2016; Withers et al., 2011).

Some authors have argued that it is easier for large companies to develop innovative outputs compared to small companies due to the opportunities, knowledge, and resources large firms have available to them (Davis & Bendickson, 2018). Although small companies commonly lack the human and financial resources needed to overcome the liability of smallness (Aldrich & Auster, 1986), I argue that some small companies are also able to deliver innovative outputs due to their use of innovation capability. I theorise that innovation capability moderates companies' ability to

develop innovative outputs, helping them overcome the liability of smallness by enabling them to focus on a reasonable number of new ideas (Chandy et al., 2006) (recognition process) and allocate resources more efficiently (Duran et al., 2016) (orchestration process). In particular, I suggest that smaller companies have greater payoffs from their innovation capability than large firms in the form of innovative outputs.

This paper brings together the liability of smallness (Aldrich & Auster, 1986; Abatecola et al., 2012) and innovation capability (Lawson & Samson, 2001) factors determining innovative outputs. Previous studies suggested that liability of smallness may affect innovation development (Abatecola et al., 2012; Aldrich & Auster, 1986), while some authors (Lawson & Samson, 2001; Withers et al., 2011) advocated that innovation capability enables the successful development of innovative outputs. Hence, the main objective of this study is to bring innovation capability into the relationship between firm size and innovative outputs and examine their role in development of innovative outputs by firms of all sizes. Exploring the role of the innovation capability in the liability of smallness–innovative outputs link, I answer the call for additional investigation of firms’ capability to specify where exactly the moderator comes into play (Schilke, Hu, & Helfat, 2018). Therefore, I ask the following research question.

*To what extent does innovation capability enable companies to generate more innovative outputs and overcome the liability of smallness?*

In order to answer the research question and fill the research gaps, this study is applied to a sample of 14,112 companies that was used to explore the relationships between innovative outputs, innovation capability, firm size (the liability of smallness), and the control variables. I used a quantitative approach to analyse the secondary dataset from the Innobarometer 2016 survey, testing the posed hypotheses.

This paper is organised as follows. First, I review the literature on innovative outputs, liability of smallness and innovation capability to develop hypothesis of the focal

relationships. Second, I describe the data and methods, develop measures and test hypotheses. Third, I report and discuss the results of the analysis. Finally, this study ends with conclusion, contributions and limitations.

### *6.1.2 Theory and hypotheses.*

#### *6.1.2.1 Innovative outputs and the liability of smallness.*

Innovation, which can be recognised as the process of converting new ideas into potentially commercialisable results (Cohen & Caner 2016), has traditionally been viewed as one of the most significant sources of competitive advantage (Cardinal, 2001), ensuring that innovation-oriented companies are able to continuously update their products and deliver innovative outputs. The goal of this innovation process is to convert initial ideas into innovative outputs, which previous research has shown to be a crucial factor in firm success (Chandy et al., 2006). By innovative outputs I mean new or significantly improved products, services, processes, market strategies, and organisational methods (Kahn, 2018). Companies' ability to deliver innovative outputs enables them to generate a high level of profitability (Artz et al., 2010). Indeed, the ability to translate an initial idea into a commercialised product is a necessary condition for companies' survival and further development in the face of growing competition. Aiming to maintain an existing market position or establish a new one, both small companies and large firms are forced to convert inputs into innovative outputs. However, companies differ in their ability to develop innovative outputs, which in turn raises the question of why some of companies are better at conversion than others (Chandy et al., 2006). In this regard, size differences may explain the variability in companies' innovative outputs since small companies experience the liability of smallness as a result of a lack of resources (Ko & Liu, 2017).

To some extent, differences in firm size affect access to resources, which is generally less constrained for large companies (Davis & Bendickson, 2018). According to Schumpeter, (1950), larger companies have greater access to financial resources than small companies (Spescha, 2018) due to credit constraints and financial market

imperfections (Cabral & Mata, 2003). Small companies tend to lack financial resources and a skilled workforce, which are embodied in the liability of smallness and help explain why new business ideas fail (Abatecola et al., 2012). While small companies tend to employ funds in a thrifty but efficient manner, large firms tend to invest money in innovative activities more intensively, aiming to achieve and sustain competitive advantage (Wakasugi & Koyata, 1997). However, if routines or internal controls are not debugged, it is unlikely that company will achieve the expected outputs (Duran et al., 2016) regardless of the amount of capital spent.

Differences in innovative ideas and resource availability can affect the circumstances under which firm size is either an advantage or a disadvantage (Cohen, Levin, & Mowery, 1987). For instance, larger companies have greater market share and greater access to resources, while smaller companies tend to have faster communication and coordination and generally spend their funds more efficiently (Spescha, 2018). Even though the number of innovations per dollar decreases with increasing firm size, which in turn indicates large companies' lower efficiency (Choi & Lee, 2018), it may be misleading to claim that small companies are more effective. Indeed, some opportunities are more resource intensive, and large companies have more capability to convert new ideas into technological innovations. Eventually, small firms tend to encounter resource limitations, which may adversely affect their potential to generate innovative outputs (Saunila & Ukko, 2014).

Since a larger firm size can be advantageous by providing more abundant opportunities and resources, which can in turn positively influence companies' ability to develop innovative outputs, I suggest the following:

*Hypothesis 1. There is a positive relationship between firm size and innovative outputs.*

#### ***6.1.2.2 The liability of smallness and innovation capability.***

Every organisation has a set of resources and capabilities that influences its capacity to introduce new products and services (Lawson & Samson, 2001). Company resources

represent combinations of tangible and intangible assets, including a firm's skilled workers as knowledge holders and financial capital (Barney, Wright, & Ketchen Jr, 2001). Large companies can easier take advantage of their human and financial capital (Schumpeter, 1950), while small companies have to overcome the liability of smallness resulting from their lack of resources. However, regardless of their size, companies have to properly manage resources (Sirmon & Hitt, 2003) to maximise their full potential. To ensure adequate resource management, companies should develop a special innovation capability to organise and exploit capital to develop recognised ideas (Withers et al., 2011). I define innovation capability as the firms' general ability to continuously shape and transform resources into innovative outputs (Lawson & Samson, 2001). Earlier contributions to this field have argued that the ability to develop innovative outputs requires innovation capability to recognise opportunities and orchestrate resources for further development (Duran et al., 2016; Withers, et al., 2011).

Building on Lawson & Samson, (2001) I propose that innovation capability involves two important abilities that enable the conversion process: (1) the potential to recognise lucrative ideas and (2) the potential to orchestrate available resources to exploit recognised ideas (Withers et al., 2011). The opportunity recognition refers to the ability to estimate the potential value of new knowledge (Shane, 2000). When attempting to recognise opportunities, small companies may experience the liability of smallness since they are often unable to attract the same skilled workers as larger firms due less optimistic prospects for long-term employment and career opportunities (Abatecola et al., 2012). Consequently, lack of knowledge and experience may affect the number of opportunities companies can recognise, giving large companies a competitive advantage over small companies.

The second ability refers to the companies' potential to organise available resources, or resource orchestration (Duran et al., 2016; Sirmon et al., 2011). Resource orchestration has value for the successful development of innovative outputs as



resource availability (Penrose, 1959; Sirmon, Hitt, & Ireland 2007). Accordingly, there are two elements of resource orchestration: (1) resource availability (Spescha, 2018; Schumpeter, 1950), and (2) efficient resource allocation (Duran et al., 2016). While large companies tend to have more resources at their disposal, small companies typically have more flexibility when making decisions and allocating resources (Saunila & Ukko 2014). For example, aggressive investments in innovation activities allow large companies to conduct riskier, more expensive, and thus more profitable projects, complicating competition for smaller firms that are less solvent (Spescha, 2018). As a result, large companies generally have more resources available (Schumpeter, 1950) to develop recognised opportunities, and small companies may experience the liability of smallness due to the shortage of financial resources (Abatecola et al., 2012).

Combining the above arguments, I propose that larger firms have higher innovation capability for recognising opportunities and orchestrating resources:

*Hypothesis 2. There is a positive relationship between firm size and innovation capability.*

### *6.1.2.3 Innovation capability and innovative outputs.*

To create innovative outputs, companies have to coordinate and synergise the innovation capability and resources at their disposal to recognise and exploit opportunities (Teece & Pisano, 1994). To do so, companies can distribute, combine, and organise their resources using their orchestration potential, which in turn enables them to exploit recognised opportunities (Withers et al., 2011). Thus, innovation capability is likely to be important for gaining a competitive advantage (Romijn & Albaladejo, 2002), since '[i]nnovation capabilities involve a firm's ability to recognize an opportunity for innovation, and then combine firm resources and capabilities to successfully exploit the opportunity through innovation' (Withers et al., 2011, 517). In other words, companies need innovation capability to recognise opportunities and manage new and existing resources so they can successfully convert opportunities into innovative outputs (Withers et al., 2011). This reasoning leads to my next hypothesis:

*Hypothesis 3. There is a positive relationship between innovation capability and innovative outputs.*

#### *6.1.2.4 Moderating impact of innovation capability.*

Resources and capabilities are important for companies' ability to generate innovative outputs and remain competitive (Withers et al., 2011). However, investing more resources in firms' innovation efforts does not necessarily lead to a competitive advantage, since resources, first of all, must be properly managed (Sirmon & Hitt, 2003). Hence, resources play an important role in the conversion of inputs into innovative outputs when opportunity recognition (Withers et al., 2011) and resource orchestration processes are fully exploited (Sirmon et al., 2011). Thus, because small company size is associated with fewer innovative outputs due to lower innovative expenditures, small firms need to possess innovation capability to overcome the liability of smallness (Huerger & Jaumandreu, 2004).

Although larger firms likely process more ideas than small firms (Chandy et al., 2006) and likely have more resources at their disposal (Schumpeter, 1950), firms of all sizes still need innovation capability to convert inputs into innovative outputs to successfully leverage their new ideas (Withers et al., 2011). According to Withers et al., (2011), the relationship between innovation capability and innovation activity can be moderated by firm age, while the role of firm size is unclear. From this point of view, I can take a fresh look at the complex role that innovation capability plays in the conversion process among large and small firms. Therefore, I expect that innovation capability moderates the relationship between the liability of smallness and innovative outputs such that firms' difficulty to attract more skilled workers and lack of financial resources can be compensated for by the ability to recognise potentially lucrative opportunities and to orchestrate resources effectively. I assume that the liability of smallness is moderated by higher levels of innovation capability, which allow smaller firms to generate more innovative outputs. Hence, I propose the following hypothesis:

*Hypothesis 4: Innovation capability moderates the relationship between firm size and innovative outputs.*

### **6.1.3 Methodology.**

#### **6.1.3.1 Sample and data.**

To examine my theorising and test my hypotheses, I used firm-level data on how companies carry out innovation from the Innobarometer 2016 survey. The European Commission conducted the Innobarometer 2016 to gather information on innovation-related activities from organisations operating in the European Union, Switzerland, and the United States. For this article, I examined companies that innovate in manufacturing, retail, industry, or services. Key decision makers were interviewed via telephone from February 1 to February 19, 2016. The survey collected information about innovation trends among enterprises, particularly about the development of innovative goods, processes, market strategies, organisational methods, or/and services in quantitative and monetary terms.

For this study, I used information on all the companies represented in Innobarometer 2016. The initial sample consisted of 14,117 companies. To build a sample dataset, I compiled and coded the data, correcting the sample for missing data. Based on the above criteria, 14,112 companies were included in my research sample, excluding five firms that had either missing or incomplete data.

*Dependent variable. Innovative outputs.* Companies' ability to convert an innovative idea from its raw form to the final result (Chandy et al., 2006) reflects the development of innovative outputs. Ideas are commercialised as certain types of innovations: namely, new or improved products, services, processes, market strategies, and/or organisational methods. Based on this fact, I measured innovative outputs in terms of firms' converted outputs, or types of introduced innovations, over a three-year period (from 2013 to 2016). More specifically, I measured innovative outputs using firms' responses to an Innobarometer 2016 question asking whether they introduced any type of innovation (i.e. good, service, process, market strategy, or organisational

method) since January 2013. In order to build the scale, I coded each answer as 1 if the firm introduced a certain type of innovation. Since Innovative outputs variable consists of several items, the observation is dropped if one of the items are missing or not applicable (N/A). To avoid the data loss (where the company reported about any type of the developed innovative outputs), I coded other answers than yes as 0, including missing values. Then, I built a composite measure of innovative outputs by summarising all types of innovations that each company introduced since January 2013. Hence, I measured innovative outputs using a six-item scale from 0 (no innovation) to 5 (all types of innovations). The Kaiser-Meyer-Olkin (KMO) value was 0.799, going beyond the recommended value of 0.6; Bartlett's test proved statistical significance; and Cronbach's alpha (Ch.a) coefficient was 0.734 (Pallant, 2013).

*Independent variables. Innovation capability.* Withers et al., (2011) measured innovation capability as the degree of resource employment needed for innovation. Hence, I measured innovation capability as investments in targeted innovative activities. Innovation activities may involve employee training, licensing, product and service design (Becker and Peters 2000), research and development (R&D) (Withers et al., 2011), software development, organisation and business improvements, and acquisitions of machines and equipment (Innobarometer 2016). In this regard, I measured innovation capability as innovation activities in which a company invested in the past. I measured firms' responses to the question about investments in (1) training; (2) software development; (3) company reputation, branding, and web design; (4) R&D; (5) product and service design; (6) organisation or business process improvements; and (7) acquisitions of machines, equipment, software, and licencing since January 2013 as a binary variable. These items indicate companies' investments in innovative opportunities and reflect their purposeful attempts to innovate (Withers et al., 2011). I coded each answer 1 if the company had invested in an activity mentioned above and 0 if the company did not invest or did not answer the question. To construct the innovation capability variable, I combined all items into one indicator. I ran a factor analysis to identify a set of factors that represents the relationship among

the group of related questions presented above. After the factor analysis, the components 1, 2, 5, 6 and 7 were left as items in a scale measuring innovation capability. Therefore, I measured innovation capability using a 6-item scale, where 0 indicates that the company made no investments in innovation activities and 5 indicates that the company invested in all innovation activities mentioned above. The KMO value was 0.790, going beyond the recommended value of 0.6; Bartlett's test proved statistical significance; and the Ch.a coefficient was 0.697 (Pallant, 2013).

To test Hypothesis 2, I included the innovation capability variable in Model 3 as the dependent variable.

*Firm size.* Since small companies may have limited access to resources and large companies tend to have abundant resources, I used firm size as a measure of the liability of smallness (Withers et al., 2011). Because the liability of smallness stems from a lack of skilled workers and financial resources in small companies, I measured the liability of smallness as the number of employees (full-time equivalent) reported in the Innobarometer 2016 survey. Firm size was represented as an ordinal variable, where 1 = 1–9 employees, 2 = 10–49 employees, 3 = 50–249 employees, 4 = 250–499 employees, 5 = 500 or more.

*Control variables.* I included several control variables that may impact the relationship in question in the analysis, including firm age, sector group, and country context.

*Firm age.* Both Hansen (1992) and Withers et al., (2011) suggested that firm age affects innovative outputs. Hence, I controlled for firm age because older firms can outperform younger firms in recognising innovative opportunities and orchestrating resources to take advantage of new ideas through innovative activities (Withers et al., 2011). In this regard, I measured firm age using a three-item scale, where 1 = firms established before 2010, 2 = firms established in 2010–2015, 3 = firms established after 2015.

*Sector group.* Sector group is a common control variable in innovation research since some sectors are more innovative than others. I measured sector groups using answers to an Innobarometer 2016 question asking companies which sector they belong to. There are four major sector groups – industry, manufacturing, services, and retail – which I operationalised as a set of dummy variables coded 1 if the firm belonged to the sector and 0 if not.

*Country context.* The Innobarometer 2016 survey was conducted among 28 member countries of the European Union, Switzerland, and the United States, which were measured as binary variables. Since previous studies on the ability to convert inputs into innovative outputs are limited to particular countries, the generalisability of their results might also be limited.

Figure 6.1 illustrates the overall research model with the variables and hypotheses.

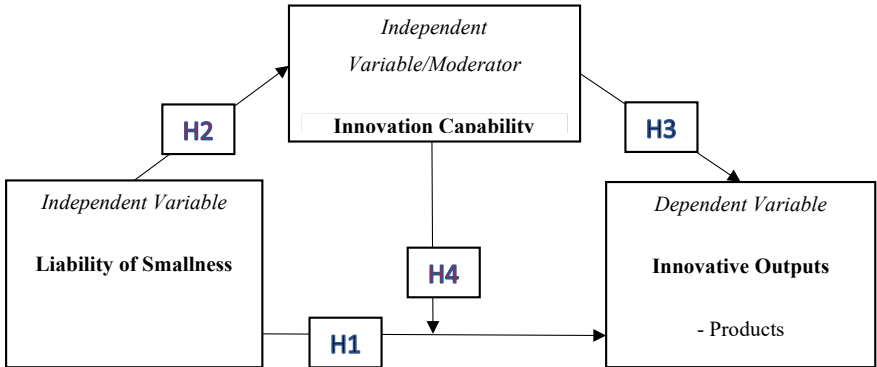


Figure 6.1 Research model.

**6.1.3.2 Descriptive statistics and analysis.**

To analyse the data, I ran a regression analysis. I conducted a preliminary analysis to ensure no violations of the assumptions of normality, linearity, and homoscedasticity. Obtained results were the subject to the robustness checks since I coded the data for Innovative Outputs and Innovation capabilities as 1 in case of a positive answer and the rest of the answers, including not applicable as 0. This method was used in order

to take into account all produced innovative outputs and all performed innovation activities that took place. This approach constitutes a rational argument, since different types of the innovation demand different types of innovation activities that sometimes are not applicable for some companies. To make a robustness check I repeated analysis with the same variables with missing values. The robustness test results did not change the conclusions I made in this article, but revealed weaker moderation effect. I also created a correlation matrix and calculated summary statistics to review measurement validity and check for multicollinearity. Table 6.1 presents the correlation matrix and summary statistics for the dependent, independent, and control variables introduced above.

Table 6.1 Correlation Matrix and Summary Statistics.

	Mean	Std.	N	1	2	3
1 Innovative Outputs	2.04	1.71	14112	-		
2 Firm Size	1.90	1.01	14112	0.22**	-	
3 Innovation Capability	3.07	1.59	14112	0.43**	0.26**	-

\*  $p < .05$ ; \*\*  $p < .01$

## 6.1.4 Results.

### 6.1.4.1 Correlation analysis.

The simple mean, standard deviation and the pairwise correlations are introduced in Table 6.1. Dependent variable (Innovative outputs) and independent variable (Firm size) are correlated with a coefficient of 0.22. Another independent variable (Innovation capability) is also correlated to the dependent variable (Innovative outputs) with a coefficient of 0.43. Furthermore, two independent variables are correlated as well with a coefficient of 0.26, suggesting no violation of the multicollinearity assumption.

My main empirical model takes the following form:

$$\hat{y} = b_0 + b_1X_1 + b_2X_2 + b_3X_1X_2 + b_4X_4 + \vec{\lambda}IND + \vec{\mu}CTY \quad (1)$$

where  $\hat{y}$  represents Innovative outputs (predicted value of the dependent variable);  $X_1$  represents Firm size; and  $X_2$  represents Innovation capability;  $X_1X_2$  is the interaction between Innovation capability and Firm size;  $b_0$ ,  $b_1$ ,  $b_2$  and  $b_3$  are regression coefficients. Additionally, I use three controls:  $X_4$  for the Firm age, and, estimated in two vectors, industry fixed effects  $IND$  and country fixed effects  $CTY$ , where  $b_4$ ,  $\vec{\lambda}$ , and  $\vec{\mu}$  are regression coefficients.

#### *6.1.4.2 Multiple regression.*

The main results of the analysis are presented both in the graphical diagrams (Figure 6.2) and the multiple regression results (Table 6.2). I used several multiple regression analysis models to examine the relationships between the dependent, independent, and control variables to test my proposed hypotheses. To conduct moderation analysis, I created the interaction term by multiplying the Firm size variable by the moderator variable Innovation capability. Then, I ran a multiple regression predicting Innovative outputs from the Firm size, Innovation capability, and Interaction term. Afterwards, I checked the result's significance and strength of the tested relationships. I followed the procedures offered by Baron & Kenny's (1986) to conduct moderation analyses. I present five models revealing the relationships between innovative outputs, innovation capability, firm size (the liability of smallness), the interaction between innovation capability and firm size, and the control variables. The results of these regressions are presented in Table 6.2; they suggested that Models 1–5 were significant.



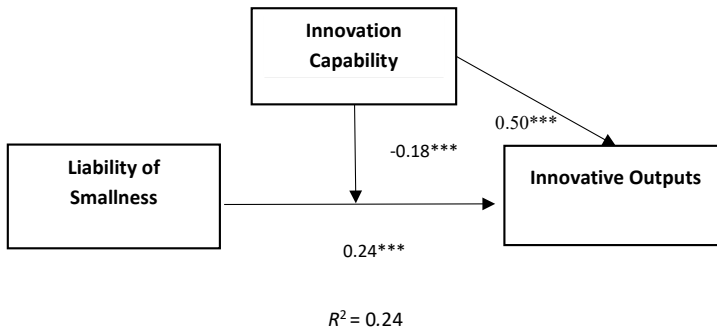


Figure 6.2 Moderation analysis – graphical representation.

Table 6.2 Multiple Regression Results: Innovative Outputs and Innovation Capability

	Model 1		Model 2		Model 3		Model 4		Model 5	
	<i>Beta</i>	<i>Std.</i>	<i>Beta</i>	<i>Std.</i>	<i>Beta</i>	<i>Std.</i>	<i>Beta</i>	<i>Std.</i>	<i>Beta</i>	<i>Std.</i>
	Innovative Outputs		Innovative Outputs		Innovation Capability		Innovative Outputs		Innovative Outputs	
Firm Size			0.23***	0.01	0.26***	0.01			0.24***	0.03
Innovation Capability							0.43***	0.01	0.50***	0.02
Firm Size x Innovation Capability									-0.18***	0.01
Firm Age	Incl.		Incl.		Incl.		Incl.		Incl.	
Sector	Incl.		Incl.		Incl.		Incl.		Incl.	
Country	Incl.		Incl.		Incl.		Incl.		Incl.	
<i>F</i> -value	20.483		43.589		43.216		120.460		125.020	
<i>R</i> <sup>2</sup>	0.046		0.095		0.095		0.226		0.243	
Adjusted <i>R</i> <sup>2</sup>	0.044		0.093		0.092		0.224		0.241	

N = 14112\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

I ran a preliminary analysis to ensure no violation of normality, multicollinearity, linearity and homoscedasticity. I applied multiple regressions to assess the relationship between firm size (the liability of smallness), innovation capability, and innovative outputs after controlling for firm age, activity sector and country. In addition, a moderation analysis revealed the role of innovation capability in companies' innovative outputs. The graphical representation of the results is shown in Figure 6.2.

#### *6.1.4.3 Hypotheses testing.*

First, firm age, activity sector, and country were tested in Model 1 (Table 6.2), explaining 4.6% of variance in innovative outputs ( $F = 20.483$ ;  $p < .001$ ). In Model 1, I regressed the dependent variable (innovative outputs) on the control variables.

For Hypothesis 1, I argued that innovative outputs are positively correlated with firm size. To test Hypothesis 1, I ran a multiple regression to explore the effect of firm size in Model 2. After the firm size variable was entered ( $B = 0.23$ ;  $p < .001$ ), the total variance explained by Model 2 significantly increased to 9.5% ( $F = 43.589$ ;  $p < .001$ ). Hence, Hypothesis 1 is supported: there is positive relationship between firm size and innovative outputs. After adding firm size (as the independent variable) and innovation capability (as the dependent variable) were added with the control variables, the total variance explained by the Model 3 was 9.5%, ( $F = 43.216$ ;  $p < .001$ ). In this model, firm size was significant ( $B = 0.26$ ;  $p < .001$ ), confirming the positive relationship between firm size and innovation capability and supporting Hypothesis 2. For Hypothesis 3, I argued that innovative outputs are positively correlated with innovation capability. I included the innovation capability independent variable in the Model 1 to examine the significance and main effect on the relationship between innovative outputs and innovation capability. Total variance explained by Model 4 was 22.6%, ( $F = 120.460$ ;  $p < .001$ ). In Model 4, the innovation capability variable was statistically significant, ( $B = 0.43$ ;  $p < .001$ ), which supports Hypothesis 3. Hypothesis 4 suggested that innovation capability moderates<sup>1</sup> the relationship between firm size and innovative outputs. I included the innovation capability independent variable and cross-product term (firm size  $\times$  innovation capability) into Model 5 to examine the significance and main effect on the relationship presented in the Model 2. In Model 5, the innovation capability variable was statistically significant ( $B = 0.50$ ;  $p < .001$ ), while firm size ( $B = 0.24$ ;  $p < .001$ ) predicted the outcome variable at the same level as in Model 2. In Model 5, the included cross-product term was significant but negative ( $B = -0.18$ ;  $p < .001$ ), suggesting the reversion in effect of the relationship between the Liability of smallness and Innovative outputs. Model 5 was also statistically significant

( $F = 125.020$ ;  $p < .001$ ) and explained 24.3% of the variance in innovative outputs, thus supporting Hypothesis 4.

Overall, I explored the impact of firm size and innovation capability on companies' innovative outputs. I find support for all posed hypotheses and summarised the findings in Table 6.3. The results demonstrated that firm size made a unique statistically significant contribution to the models predicting innovative outputs. However, innovation capability had a moderation effect on this relationship. These results are further considered in the 'Discussion' section.

Table 6.3 Hypotheses test.

<b>Hypothesis</b>	<b>Finding</b>
<b>H1:</b> Firm Size → Innovative Outputs	Supported
<b>H2:</b> Firm Size → Innovation Capability	Supported
<b>H3:</b> Innovation Capability → Innovative Outputs	Supported
<b>H4:</b> Firm Size × Innovation Capability → Innovative Outputs	Supported

### *6.1.5 Discussion*

This study investigated the moderation effect of innovation capability on innovative outputs among large and small companies in terms of the liability of smallness. Previous research on the liability of smallness (Abatecola et al., 2012; Aldrich & Auster, 1986) has suggested that new business ideas can fail in small companies due to their lack of skilled workers and financial resources, which can in turn affect innovative outputs. However, earlier studies on innovation capability (Romijn & Albaladejo, 2002; Withers et al., 2011) have stressed that recognising a moderate number of new ideas (Chandy et al., 2006) and effectively orchestrating resources (Duran et al., 2016) are more important for the successful conversion of innovative ideas than resource abundance. In this study, I showed that small companies can successfully convert ideas into innovative outputs by integrating innovation capability that helps them overcome

the liability of smallness. After controlling for firm age, sector group, and country, my analysis confirmed the importance of firm size and innovation capability for firms' ability to efficiently convert ideas into innovative outputs.

With these findings, this study makes several contributions to the innovation literature. First, the results indicate that firm size is positively associated with innovative outputs, as suggested in Hypothesis 1. Thus, larger companies deliver more innovative outputs, but smaller companies do not enjoy these same size advantages. This result is not completely new and confirms the outcomes of previous studies regarding the effect of firm size on innovative outputs (Wakasugi & Koyata, 1997). Second, it has been expected that firm size is positively correlated with innovation capability since larger companies have more skilled workers to recognise potentially applicable ideas and more abundant resources (Abatecola et al., 2012), as I argued in Hypothesis 2. This study's results indicated that innovation capability explains the variance in innovative outputs, as Hypothesis 3 proposed. Thus, I extend previously examined arguments that larger firms are able to develop more innovative outputs due to better innovation capability (Withers et al., 2011). Finally, Hypothesis 4 contributes to the field of technology and innovation studies by showing that innovation capability influences the relationship between the firm size and innovative outputs as a moderator. Previous research (Withers et al., 2011) focuses on the relationship between firm age, innovation capability and innovation, while this study brings theorising on liability of smallness into the discussion. Furthermore, I introduce firm age as control variable in the analysis, where firm age was found to be insignificant, while firm size is highly significant, suggesting that firm size may have a greater influence on innovation development than firm age.

Even though larger firms have more abundant human and financial resources to develop innovative outputs, small companies that can effectively employ the recognition and orchestration processes have greater payoffs from innovation capability and are thus able to compete with large firms. In addition, the results

indicated that the moderation effect of innovation capability weakens with increasing firm size. This finding suggests that small companies are likely to have more innovative outputs if their recognition and orchestration processes are fully developed compared to large companies that can compensate for a lack of innovation capability with their abundant resources.

### *6.1.6 Conclusion.*

In this study, I examined the impact of firm size (the liability of smallness) and innovation capability on firms' innovative outputs. Responding to the call for more research on capabilities (Schilke et al., 2018), this study explores under what conditions companies generate more innovative outputs and overcome the liability of smallness and finds that innovation capability enables the conversion of inputs into innovative outputs. Moreover, innovation capability is likely to be a highly relevant condition determining the extent to which the liability of smallness may affect development of innovative outputs.

#### *6.1.6.1 Contributions and limitations.*

Based on the results of this study, I suggest some theoretical and managerial implications. From a theoretical point of view, this paper helps to understand how firms, depending of their size, integrate innovation capability to stimulate innovation by means of opportunity recognition (Withers et al., 2011) and resource orchestration (Duran et al., 2016) processes; thus extending existing literature on innovation capability and enabling a better understanding of how innovation capability acts to enhance innovative outputs and help overcoming the liability of smallness. From a business practice perspective, this study may help managers to identify specific tactics for integration firm's innovation capability for successful development of innovative outputs, since innovation capability is 'serve[d] as flexible strategic option"(Moorman & Slotegraaf, 1999, 252)

This study has some limitations. First, the study is limited by the data from Innobarometer 2016 since the survey was not originally developed to test the

relationship between innovative outputs, innovation capability, and the liability of smallness. Next, the measures of the dependent and some independent variables (e.g. innovation capability) may not fully reveal the complexity of innovation process. Specifically, the innovative outputs concept may show changes depending on what the respondents understand by innovation. To reduce possible representative bias, I used a large sample that minimises the risk. To eliminate the issue with innovation capability variable I attempt to follow approach offered by Withers et al., (2011) that measure innovation capability relying on how firm manages resources and capabilities. Finally, the cross-sectional nature of the data prohibits me from exploring the entire conversion process from inputs to innovative outputs. These boundaries open up new opportunities for future research to measure the full conversion process over time.

#### *Notes*

1 Baron & Kenny (1986) stated that “moderation implies that the casual relation between two variables changes as a function of the moderator variable” (1174).

# Appendix

Table 6.9 Core Constructs (Dependent and Independent Variables) and Their Measurement Items

Construct	Ch.a	Items
Technological Innovation Outputs (Time 2)	0.776	<i>To what extent has the project/activity led to:</i> (1) Improving the design, properties, and qualities of existing products? (2) The development of a new product? (3) The development of a new service? (4) The development of a new production process?
Non-Technological Innovation Outputs (Time 2)	0.752	<i>To what extent has the project/activity led to:</i> (1) The use of new sales channels or marketing methods? (2) The introduction of products/goods and/or services to new customer groups? (3) New methods for organizing work responsibilities and decisions within the company? (4) New methods for organizing external relationships with other companies or public institutions?
Internal Innovation Capabilities (Time 1)	0.755	<i>To what extent does the project/activity contribute to the following innovation behavior:</i> (1) Increased focus on development and innovation? (2) Better utilization of knowledge? (3) Competence development in myself/employees?
External Innovation Capabilities (Time 1)	0.761	<i>To what extent does the project/activity contribute to the following innovative behavior:</i> (1) Hiring new employees? (2) Seeing new opportunities in international cooperation? (3) The development of collaboration/networks?





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Where there’s a will, there’s a way: The role of innovation capabilities in the development of innovation outputs



The modern business environment is changing unexpectedly and unpredictably. Responding to these changes, some companies are able to innovate, recognizing new ways to stay competitive, while others continue to tread the beaten track, gradually losing their competitive edge. This dissertation explores the role of organizational innovation capabilities in the development of innovation (outputs). Moreover, I look to the emerging literature to distinguish between the internal and external aspects of organizational innovation capabilities, activities associated with them, and their manifestation in organizations and projects. In this dissertation, I use three different surveys and perform quantitative analysis to understand the role of organizational innovation capabilities in the development of innovation outputs.

This dissertation consists of an introductory part and three independent research papers. Although all three research papers are quantitative and empirical, they make conceptual and theoretical contributions. Paper 1 explores internal aspects of innovation capabilities, revealing the different ways organizational innovation capabilities influence companies' ability to develop innovation outputs depending on their size. Paper 2 investigates external aspects of innovation capabilities in terms of scientific and business collaboration, both of which contribute to the development of innovation outputs. Paper 3 looks into both internal and external aspects of organizational innovation capabilities and their influence on innovation outputs in projects.

The overall findings of this dissertation show that both internal and external aspects of organizational innovation capabilities are important for firms aiming to develop innovation outputs. In this dissertation, a number of implications are drawn, and avenues for further research on innovation capabilities are presented.