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BY
DIANE FILIP

DISSERTATION SUBMITTED 2016

AALBORG UNIVERSITY
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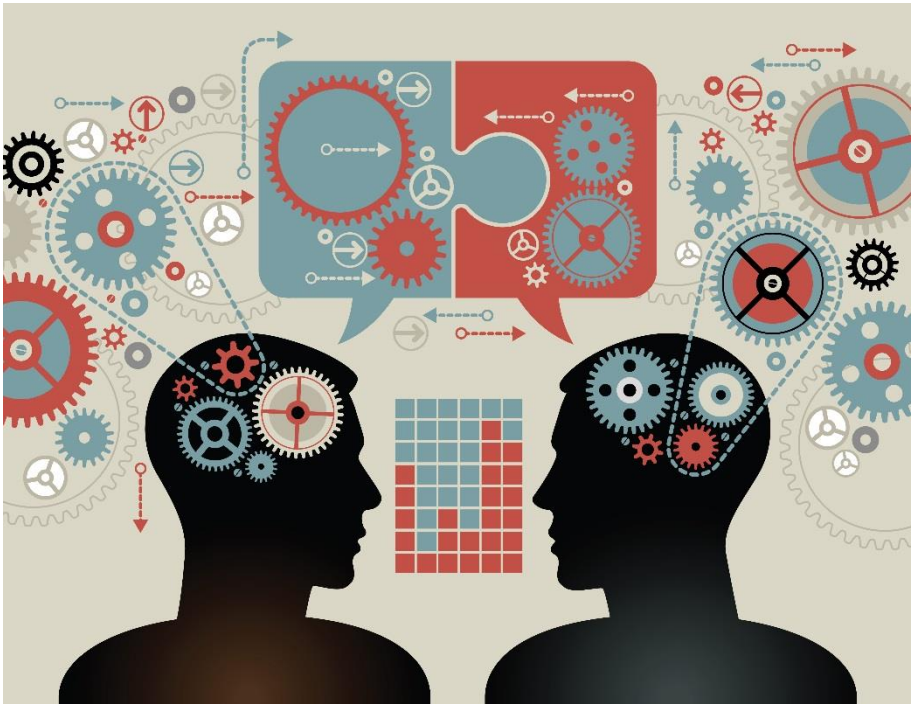

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PhD dissertation submitted

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Preface

This PhD dissertation is the outcome of a three-year PhD project initiated in 2012 by Insero Horsens, a foundation that financially supported the PhD project together with Familien Hede Nielsens Fond. This PhD dissertation would not have been a reality, if it were not for your support.

The past three years have been an incredible journey and invaluable learning process as a PhD student, with most of my time spent at Insero Science Academy (part of the Insero Group). When I started the PhD project, I would never have imagined how much I could possibly learn and in which directions my mind and thoughts would take me – and this project.

At the start of my third year, I was inspired to create a game – an exploratory design game – together with Associate Professor and co-author of a chapter, Hanne Lindegaard. We call it the *Object Game*. Its purpose is to explore how objects are used in collaborative innovation projects between SMEs and Academia, and how objects facilitate different types of knowledge flows. The Object Game was used in a co-design workshop in the summer of 2015, and it showed to be of great value – to research and to practice. Letting my inner creativity loose during the design and development process of this exploratory design game, I found a passion for this, which I hope I can bring with me in my future endeavors in the world of practitioners.

During the PhD years, 'life is a rollercoaster' is a good description of the journey. Both in terms of emotional 'ups and downs', which is an evitable part of expanding the knowledge horizon and personal growth as a researcher, but also in an abstract sense, by moving from theory to practice – from sky to earth – and back again. People, who have been part of this project, and people I have met along the way, all have had their share in paving the way for this PhD dissertation. I want to thank all of you.

I am grateful for guidance and support from my three supervisors, Professor John Johansen, Professor Michael S. Dahl, and Hans Jørn Hansen. Thank you for giving me the latitude to form my own thoughts and grow as a researcher. Thanks to all my colleagues at Insero for the great support these three years. I am very thankful to the key informants for your time, interest, responses and openness to provide valuable insights to your realities.

A special thanks to the co-authors, Bettina Dencker Hansen (PhD), Thea Thorsgaard Frølunde (MSc), and Associate Professor Hanne Lindegaard for the exploration and productive discussions during our research – and for your friendship.

Thanks to Associate Professor Ina Drejer for helping with statistical data for this PhD project, and thanks to Professor Poul Houman Andersen for your guidance on research methods. I want to thank Associate Professor Markus Perkmann from Imperial College for guidance and further suggestions on research area of brokers and intermediaries.

Thanks to Professor Christian Clausen and Associate Professor Søren Kerndrup for the inspiring discussions on innovation processes and boundary objects during the PhD course and for introducing me to Associate Professor Hanne Lindegaard. I also want to thank Professor Harry Boer for introducing me to the concept of continuous innovation and the Continuous Innovation Network (CINet).

To my closest friends, thank you for understanding my priorities and supporting me all the way. Last, and most important, to my parents, Mariana and Joseph, and to my beloved Sebastian, thank you for your patience, understanding, support, and loving. Without you, I could not have completed this. Sebastian, thank you for your warmth, cheerfulness and for keeping me grounded. Thank you all for your encouragement and belief in me.

Diane Filip

Abstract

How do SMEs collaborate with Academia? This is the focal point of this dissertation. Firms collaborate with academia through different mechanisms, depending on the purpose of the interaction. The mechanism studied is *collaborative innovation projects* that are coordinated and facilitated in a Danish regional program. The purpose of these projects is to create growth in SMEs via new knowledge creation, strategic change, and innovation.

The PhD project explores the roles of *brokers, capabilities,* and *objects* in making knowledge *flow* between the two knowledge bases of SME and Academia. The core of this dissertation is a qualitative research study based on multiple case studies. An exploratory design game – the *Object Game* – is designed and developed in the PhD study and applied in a workshop setting. Findings from the multiple case studies are integrated into the design game. The purpose of the Object Game is to explore the role of objects in collaborative innovation projects, and it functions as a research tool and a reflective tool.

The ultimate goal of any firm is to survive or grow. Innovation can lead to this goal. Innovation is essentially the combination of existing ideas used in a new context, and this could arguably be the case when a firm and an academic researcher combines their two (different) knowledge bases. *Collaborative innovation* is the process in which two or more knowledge bases interact and combine their experiences, capabilities and ideas, which may occur in a limited time, through for instance *projects*. Projects indicate a start and a finish – and an *intended* goal. A goal of finding the means for survival or growth. Therefore, *collaborative innovation projects* between SMEs and Academia is an important mechanism to study, understand, and learn from.

The PhD dissertation is divided into four parts. *Part I* is the introduction and research approach, followed by *Part II* with the literature review. *Part III* is the empirical research and *Part IV* concludes by summarizing the findings and discussing the contributions to theory, practice, and policy.

By researching the mechanism of collaborative innovation projects in a formalized structure, the regional program, we gain an understanding of how brokers, capabilities, and objects can facilitate knowledge flows between SMEs and Academia. The findings take an important step in shaping and defining (new) *collaborative boundary practices* to be applied in other contexts where actors from different knowledge bases and boundaries interact, share and create knowledge – ultimately leading to strategic change and innovation.

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PART III. EMPIRICAL RESEARCH

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PART I.

INTRODUCTION

How do SMEs collaborate with Academia?

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Chapter 1. Introduction

"Out of clutter, find simplicity.
From discord, find harmony.
In the middle of difficulty lies opportunity"
– Albert Einstein

1.1. Introduction to area of research

Only a limited number of small and medium-sized firms (SMEs) collaborate with researchers at universities and other knowledge institutions. By combining knowledge from academia and practical knowledge in the firms, new knowledge can be generated in the context of collaboration – knowledge to be captured by the firm. Knowledge from the outside is a source of innovation (Drucker, 1985), therefore the knowledge base of the academic researcher is a potential source of innovation. A different source, which in most cases is peripheral to the SMEs sources of development and innovation. Innovation is a strategy of growth or survival (Teece, 2007; Helfat et al., 2007; Helfat and Peteraf, 2015), and innovation is based on knowledge integration (Grant, 1996a, 1996b).

Collaboration is an inevitable part of innovation (Dodgson, 2014). Through collaboration, and thus interaction between individuals from different boundaries, knowledge and ideas are combined and recombined for new and innovative products, services, or processes – for recombinant innovation (Hargadon, 2003). Knowledge brokering is a process of recombining existing ideas, objects, and people (Hargadon, 2014). Broadly speaking, knowledge brokering is a process through which knowledge is reused in new contexts. Indeed, sometimes the best ideas come from outside a firm's industry (Poetz et al., 2014). An example is where "3M developed a breakthrough concept for preventing infections associated with surgery after getting input from a theatrical-makeup specialist who was knowledgeable about preventing facial skin infections" (Poetz et al., 2014). According to the study by Poetz et al., (2014), "the more distant the field, the more novel the ideas," and managers need to search in distant analogous fields by first identifying the essence of the problem that they wish to solve.

With distant fields and types of knowledge comes also a different type of distance – the *perceived* distance between the business world and the world of academia. A distance based on differences between firms and academia, and this could be coined 'perceptual or cognitive distance'. Thus, a *gap* between two worlds leading to *perceived* barriers, which are primarily rooted in *differences*, including language,

time horizon, culture, expectations, daily activities, communication styles (Davenport et al., 1999; Iles and Yolles, 2002; Perkmann and Salter, 2012; Tartari et al., 2012). Lack of incentives and unclear structures to access knowledge at universities are some of the impediments for collaborative university-industry interactions.

Not only are there great differences between the business world and universities, there are also discrepancies related to the nature of the firms, i.e. SMEs and large firms (with 250 or more employees). The differences are bound in "organizational structures, managerial styles, responses to the environment, and how they [small vs. large firms] compete" (Bierly and Daly, 2007; 46). Relating to previous research, Bierly and Daly (2007) state that SMEs must overcome size disadvantages (i.e. competitive advantages of large firms including enhanced market power, economies of scale, reduced costs of inputs, etc.) by creating advantages in flexibility of production, speed of attack, niche strategies focusing on quality and price, and disrupting the status quo through innovation.

In contrast, larger firms have sufficient resources to invest in activities that generate innovations, i.e. R&D, market exploration, and finance collection; whereas, SMEs lack human and financial resources to devote to innovative efforts and practices (Parrilli et al., 2010). SMEs, whether as start-ups or in existence for a long time, have a stronger need to collaborate because of their lack of internal resources and have limited resources for basic research (Katzy et al. 2013). However, SMEs also innovate in a different way than larger firms, as well as they generally face more uncertainties and barriers to innovation (Roxas et al., 2011).

People and objects can cross boundaries – organizational and institutional boundaries – as well as geographical and knowledge boundaries, through for instance the mechanisms of collaborative projects (e.g., Bengtsson et al. 2015). People crossing boundaries are often called *brokers* or *innovation intermediaries* (e.g., Bessant and Rush, 1995; Hargadon, 1998; Chesbrough, 2006; Howells, 2006; Akkerman and Bakker, 2011a, 2011b). Similarly, objects crossing boundaries are often called *boundary objects* (Star and Griesemer, 1989; Carlile, 2002; Akkerman and Bakker, 2011a, 2011b; Nicolini et al., 2012), and objects such as game materials in Design Games function as boundary objects (Brandt et al., 2008).

Essentially, it is about *knowledge flows* (Tidd and Bessant, 2013), and managing the processes, people, and objects through which knowledge flows. But what is more important – people or process? Both, is the prevailing answer (Ovans, 2015):

> "People matters; process matters. Talented people can be hobbled by poor processes; hesitant people can be uplifted by smart processes. In the best of all possible worlds, extraordinary people pursue innovative ideas through processes that are perfectly suited to their talents. In the real world, less-than-perfect people are wise to use all the help they can get." (Ovans, 2015)

The act of opening up for collaborative mechanisms with external knowledge actors from, for instance, universities and higher educational institutions (HEIs), is an organizational innovation (e.g., OECD, 2005). In order for managers (e.g., CEOs) to manage collaborative innovation, the understanding of the process is crucial. Learning from others, who have been successful in collaborating with academic researchers, and understanding the elements of collaborative innovation projects, is the case at heart.

The state of collaborative innovation in Denmark is presented in an empirical overview in the next section. This is a 'landscape view' and gives a 'status' of how 'many SMEs collaborate with external knowledge actors, including academia.

1.2. An empirical overview of collaborative innovation in Denmark[1]

The Danish landscape of firms in Denmark, as in many other European countries, has around 99.7 percent small- and medium-sized enterprises (SMEs), out of approximately 213.000 firms, and SMEs account for around 65 percent of total employment (Eurostat, 2012). Large firms represent only 0.3 percent of all Danish firms. Micro firms with less than 10 employees account for approximately 85 percent of the Danish business landscape.

This empirical overview gives a 'landscape view' on the innovation collaboration *frequency* between Danish SMEs and the research community. The descriptive statistics for the empirical overview are derived from the *Community Innovation Survey (CIS)* in Denmark for the years 2008 to 2010[2]. This *frequency* is valuable in order to establish a 'baseline' of how many SMEs collaborate with the different types of knowledge institutions. These selected knowledge institutions and organizations are 'external knowledge actors' that represent the research community.

The reason for this is that a majority of case studies and best practices originate from universities collaborating with large firms and corporations – a university perspective – and therefore firm size in terms of employees is of special importance, as well as perspective, when investigating how SMEs collaborative with academia. The four types of actors are termed *external knowledge actors* and are a group of *knowledge institutions (and organizations)*. The research in this PhD dissertation is primarily analyzed from a firm's perspective, therefore the use of the term 'external' in order to illustrate that the focal point is that of the firm. The case studies and research in this PhD dissertation focuses primarily on part of the research community – 'academia' – which are academic researchers at universities. The processes, or set of

[1] This section is a newer verison of a paper presented at the DRUID Academy Conference, Rebild Bakker, Aalborg, Denmark, January 15-17, 2014. Title of the paper: "A helping hand – Enhancing the knowledge base of SMEs"

[2] See *Appendix E* for methods.

activities studied, are collaborations between the two main actors: SMEs and academic researchers.

These university-industry collaborations – the *innovation collaborations* – are in the case studies the focal part of the research. Those studied are referred to as 'collaborative innovation projects' throughout the PhD dissertation. According to the Oslo Manual of 2005, "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 in business practices, workplace organization or external relations" (OECD, 2005; 46). Collaboration can be defined as "the shared commitment of resources to the mutually agreed aims of a number of partners" (Dodgson, 2014; 462). As defined by Statistics Denmark:

> "'Innovation collaboration' includes active participation in innovation activities with other firms, universities and other research institutions. The collaboration must not result in immediate commercial benefits for both parties. Pure outsourcing of innovation activities, which do not involve active cooperation, is not included."

The underlying assumption for university-industry collaboration, through for instance collaborative innovation projects, is that firms can enhance their knowledge base by interacting and collaborating with this type of external actor – the external *knowledge* actor. Another assumption is that the capacity of an SME grows through accumulated learning. By collaborating with external knoweldge actors, firms can draw on external knowledge sources and interactively learn and be innovate. As stated by Lundvall (2010), assuming that the most fundamental resource in the modern economy is *knowledge*, then the most important process is learning, which is described as predominantly being an interactive and thus a socially embedded process.

Knowledge, learning and interactive process are arguably prerequisites for collaborative innovation. If ideas are conveyed into tangible or organizational outcomes – commercialized or implemented – then the outcome of the collaboration may be one of the four innovation types, which are product innovation, process innovation, marketing innovation, and organizational innovation. According to OECD (2005), these are defined as the following:

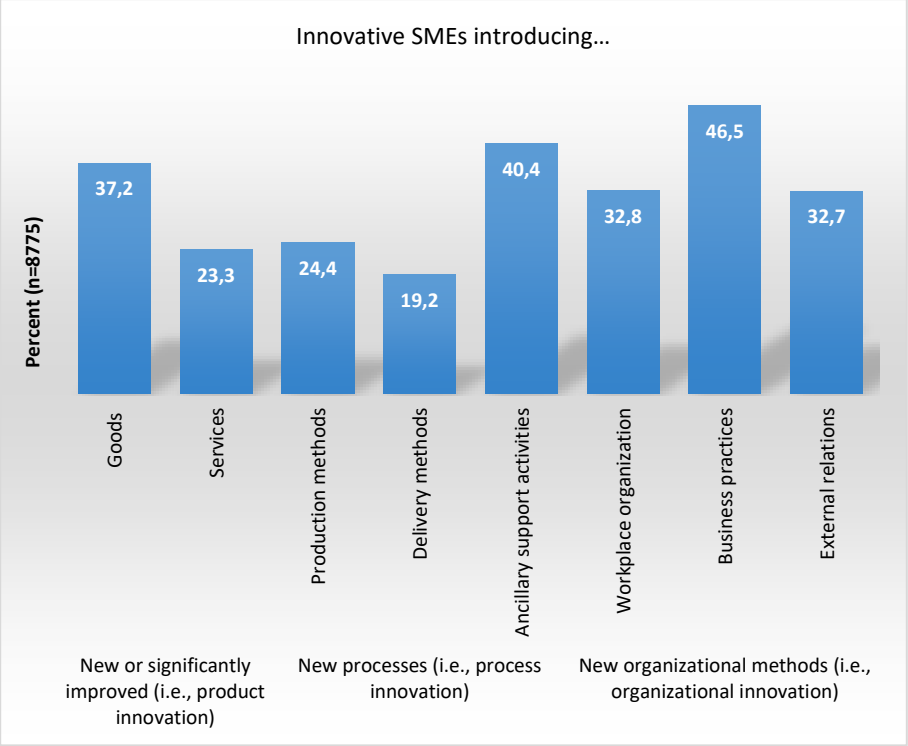
- *A* product innovation *is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. (p. 48)*
- *A* process innovation *is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. (p. 49)*

- *A* marketing innovation *is the implementation of new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. (p.49)*
- *An* organizational innovation *is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations. (p.51)*

The definition of an *innovative SME* is a firm "that has implemented an innovation during the period under review" (OECD, 2005; 47). *Figure 1.1* exhibits the percentages of innovative SMEs introducing various types of innovations categorized into three innovation types – products, processes, and organizational – as presented in this outline:

Product innovation	▪ Goods ▪ Services
Process innovation	▪ Production methods: *techniques, equipment, and software used* ▪ Delivery methods: *logistics, delivery of final products* ▪ Ancillary support activities: *purchasing, accounting, maintenance, etc.*
Organizational innovation	▪ Workplace organization: *responsibility, decision making* ▪ Business practices: *routines/procedures* ▪ External relations: *organizing relations, new types of collaborations, etc.*

Figure 1.1. Innovative SMEs introducing various types of innovation, Denmark (2008-2010).



Source: *Statistics Denmark's R&D and innovation 2010 (Community Innovation Survey).*
Base: *Innovative SMEs, n=8775.*

Figure 1.1 shows that Danish innovative SMEs are mostly organizational innovative by implementating new organizational methods, which are primarily business practices, routines and procedures. A relatively high number of innovative SMEs (32.7 percent) are engaging with external actors and forming external relations. This is a positive sign, indicating that SMEs are opening up their internal processes to include external sources. This type of innovation process is often referred to as *Open Innovation*, which is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, 2006; 1).

In recent years, universities have been pursuing, to a certain degree, the role and responsibility of being more *entrepreneurial* (Etzkowitz et al., 2000), including *the third mission* of economic development (Readings, 1996), in addition to teaching and research. This is achieved by commercializing science and by interacting with firms.

Through innovative activitity, the society gains from the basic research conducted in the academia. The research community include the four selected knowledge actors, which are formal institutions and organizations producing and transferring knowledge, influencing learning processes of other organizations, including SMEs (e.g., Johnson, 2010).

The 'intermediary organizations' have been established as one of the main mechanism to channel knowledge produced in the scientific world to be spilled over to firms (ERAC, 2012), in order to *bridge* the two worlds (e.g., Bessant and Rush, 1995). In Denmark, the 'GTS-institutes' are established as bridge-building institutions, and they are assumed to collaborate with especially SMEs on innovation, applied research, technology, and knowledge sharing.

Figure 1.2 exhibits how many innovative SMEs (*n=8775*) engage in *innovation collaborations* with the research community. The research community (i.e. knowledge institutions) includes the following selected four types of external knowledge actors:

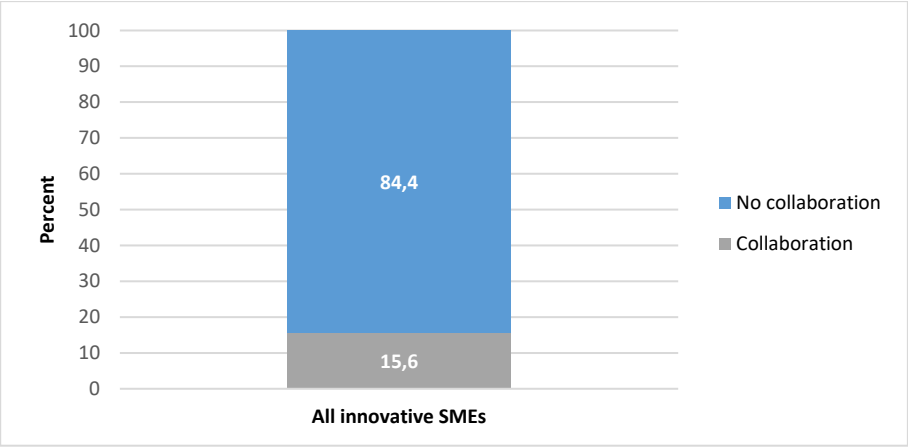
1) GTS-institutes[3] (approved technological institutes);
2) Universities/higher education institutions (HEI);
3) Private R&D-firms (consultants, private laboratories and research institutions); and,
4) Public research institutions.

Figure 1.2 gives an overall picture of how many innovative SMEs collaborate with the research community (15.6 percent) and how many that have no collaboration with these types of knowledge actors (84.4 percent) in the years from 2008 to 2010. What we do not know, is how many *non-innovative SMEs* collaborate with knowledge actors in the same time period.

As *Figure 1.3* shows, 15.6 percent of innovative SMEs collaborate with *at least one* of the four external knowledge actors. For instance, 9.3 percent of SMEs collaborated with one knowledge institution and 3.7 percent with two of the knowledge institutions. This figure only displays that interaction with one or more external knowledge actors is present during the time period 2008-2010, but not how often a firm collaborates with the same partner at the years 2008, 2009, and 2010.

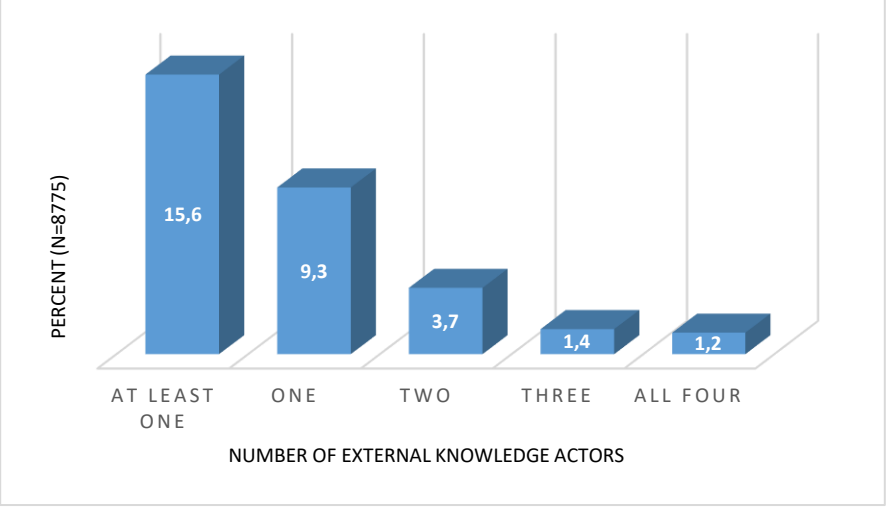
[3] The objective of the GTS-institutes ('Godkendte Teknologiske Serviceinstitutter') is to create more innovative and competitive Danish firms, which is done through sales of knowledge, technological services, and collaborations with firms – in particular SMEs. The GTS-institutes focus on development and implementations of new knowledge, including testing, product and process optimization, quality assurance, certifications and benchmarking. (GTS, 2013)

Figure 1.2. Innovative SMEs collaborating with at least one of the four external knowledge actors vs. innovative SMEs with no collaboration.



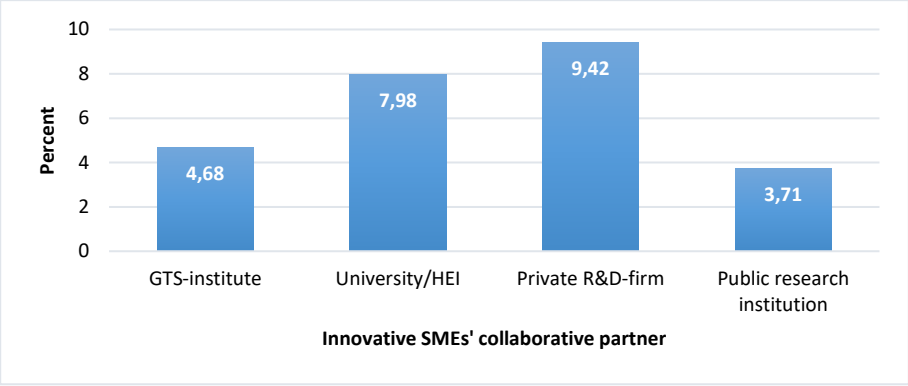
Source: *Statistics Denmark's R&D and innovation 2010 (Community Innovation Survey).*
Base: *Innovative SMEs, n=8775.*

Figure 1.3. Innovative SMEs collaborating with one or more of selected group of external knowledge actors.



Source: *Statistics Denmark's R&D and innovation 2010 (Community Innovation Survey).*
Base: *Innovative SMEs, n=8775.*
Note: *84.4% have not collaborated with any of the four types of external actors.*

Figure 1.4. Innovative SMEs collaborating with selected group of external knowledge actors.



Source: *Statistics Denmark's R&D and innovation 2010 (Community Innovation Survey).*
Base: *Innovative SMEs, n=8775.*

Figure 1.4 shows that innovative SMEs interact primarily with *private R&D-firms* (9.42 percent) and secondly with *university/HEI* (7.98 percent). The figure also exhibits that innovative SMEs collaborate more with *universities/HEI* (7.98 percent) than with *GTS-institutes* (4.68 percent) in the years 2008-2010. In sum, the descriptive statistics reveal that innovative SMEs prefer to collaborate with private R&D-firms, as well as SMEs' second choice are universities and higher educational institutions (HEIs).

An interesting finding is that more innovative SMEs engage in innovation collaborations with universities and higher educationsal institutions (HEIs) than with GTS-institutes[4] (intermediary organizations). These statistics display a *closer link* between innovative SMEs and academia than between innovative SMEs and the intermediary organizations 'GTS-institutes'.

This is perhaps surprising as the have been established as *bridging mechanisms* between the academic community and firms; *GTS-institutes* as *bridges* in the Danish innovation systems are not the preferred choice of innovative SMEs. According to the self-reporting of firms, collaborating with *universities and HEIs* is preferable over collaborating with *GTS-institutes*. The reason for this is not evident in the data. This may possibly indicate a positive effect of the universities' initiatives to become more entrepreneurial and thereby support the economic development through commercialization and interaction with firms (in addition to teaching and research).

[4] Ministry of Higher Education and Science. Nine GTS-institutes – Approved Technological Institutions (2015): http://ufm.dk/en/research-and-innovation/cooperation-between-research-and-innovation/infrastructure-between-research-and-industry-gts/infrastructure-between-research-and-industry

What causes more innovative SMEs to collaborate with universities and HEIs rather than GTS-institutes (*bridge-building institution*) is subject for further investigation – and beyond the scope of the PhD dissertation.

Nonetheless, innovative SMEs collaborate predominantly with another type of intermediary organization – the privat R&D-firms – including consultants, private laboratories, and private research institutions. The multiple case studies in the PhD dissertation explore the 'successful' innovation collaborations, i.e. collaborative innovation projects, between SMEs and academia, which according to these findings are the secondmost preferred external knowledge actors of innovative SMEs in Denmark.

Overall, this overview of the collaborative innovation gives a 'status' of how many SMEs collaborate with external knowledge actors, including academia (statistics from 2010). 7.98 percent of innovative SMEs collaborate with Universities and HEIs (*figure 1.4*), which is one of four categories of external knowledge actors (as defined in this dissertation). More firms should be able to broaden their horizon and integrate knowledge from academia as well, and thereby collaborate with more and different external knowledge actors (*figure 1.3*). The number of innovative SMEs who collaborate with one or more of the four types of external knowledge actors should increase to a higher percentage than 15.6 percent (*figure 1.2*). In this way, the statistics would also increase for how many SMEs introduce new organizational methods, thereby "external relations" could be greater than 32.7 percent (*figure 1.1*), which in turn will make more SMEs organizational innovative. In sum, focusing on facilitating collaborations between SMEs and academia supports organizational innovations in firms. How these collaborations can be facilitated, and how this may benefit the firms, will be answered in the empirical research of the PhD project.

The next section introduces policies and demand-driven collaborative projects in a Danish context and outlines the effects of policies, as well as briefly introduces research in the area of university-industry collaboration. These are initiatives and policies to make more SMEs innovative and create growth – in Denmark and Europe – by engaging in innovation activities and external relations.

1.3. An introduction to policies, actors, and demand-driven collaborative projects

At a policy-level, there is a great focus on innovation both nationally and in the European Union (EU). In 2010, the European Union launched a ten-year jobs and growth strategy called *Europe 2020* to create conditions for smart, sustainable and inclusive growth, in order to boost the European economy[5]. At the EU-level, innovation is recognized as the main driver of economic growth in the EU (EC, 2013).

[5] European Commission. Europe 2020. 'Europe 2020 in a nutshell' (2015): http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/index_en.htm

EU has therefore implemented a Europe 2020 initiative – *Innovation Union* – aiming at improving innovation performance by improving conditions and access to finance through various EU-programs, including *Horizon 2020*, an SME instrument that helps bridge the gap between research and the market[6].

In Denmark, there are innovation policies to boost SMEs' innovation activities with knowledge institutions, as for instance the *InnoBooster* program[7], formally known as "*Videnkupon"* and *"Videnpilot" (in Danish*). A peer-review of the Danish research and innovation system outlines recommendations for strengthening the innovation system by creating a simplified funding system (ERAC, 2012). In order to raise the innovation capacity and growth in SMEs, the report recommends, "The potential for the design of measures to encourage large and small companies, together with research institutes, to undertake cooperative projects or to engage in dialogue over shared innovation requirements should be investigated" (ERAC, 2012; 5). In addition, the report also recommends to further develop demand-side instruments and policies, such as *"Videnkupon"* and *"Videnpilot",* to balance out the traditional, supply-side policies under which the Danish system primarily operates. Nevertheless, innovation instruments, such as *"Videnkupon"*, attract SMEs who have not previously collaborated with knowledge institutions, and many of those have less than 50 employees (F&I, 2008).

Under the *Innovation Fund Denmark* ("*Innovationsfonden"*), an SME, entrepreneur or academic researcher can apply for DKK 50.000 to DKK 5 million for the commercialization of ideas resulting in jobs creation and growth. According to an evaluation report on the *"Videnkupon"* based on 330 projects completed in 2013[8], *95 percent* of the firms considered the program a success, with *90 percent* willing to continue the collaboration with the particular knowledge institution and *87 percent* willing to collaborate with other knowledge institutions. In this evaluation, *82 percent* of the firms would not have initiated the project without the option of public co-financing. According to this, public funding and investment is an important role of governmental bodies in creating regional or national innovation ecosystem, e.g. 'Triple Helix' (Etzkowitz and Leydesdorff, 2000; EC, 2011). This also indicates that SMEs are willing to collaborate with knowledge institutions, and consider such programs a success, if financial incentives are provided through these initiatives.

Public R&D investment was about *1 percent* of GDP in 2012, which is above OECD standards; Denmark is number four, right after Iceland, Finland, Sweden, and followed by Korea and Germany (UFM, 2014). There is great uncertainty in the causal effects of research results and findings to economic growth; however, the estimated time of academic research being channeled to industrial commercialization ranges

[6] European Commission. Research & Innovation – SME: http://ec.europa.eu/research/sme-techweb/index_en.cfm & European Commission. Horizon 2020: https://ec.europa.eu/programmes/horizon2020/en/h2020-sections
[7] Innovation Fund Denmark. InnoBooster program (2015): http://innovationsfonden.dk/sites/default/files/retningslinjerinnobooster10.07.2015.pdf
[8] Ministry of Higher Education and Science. Evaluation Report (2014): http://ufm.dk/aktuelt/nyheder/2014/filer/evalueringsrapport-videnkuponordningen-2013.pdf

from six to 20 years, depending on the research field, and is distributed along various pathways (e.g. KSA, 2012). Nonetheless, the annual value-added per firm is *9 percent* for R&D-active firms that collaborate with both universities and GTS-institutes, as compared to R&D-active firms without this type of collaboration (F&I, 2011). Another report that surveyed 127 firms states, *89 percent* of the firms responded that, in some or high degree, transfer of knowledge and competences is an outcome of collaborating with universities, as well as *64 percent* of the firms responded that, to some or high degree, believe that collaborating with the university strengthens their competitiveness (Oxford Research, 2011). Hence, there seems to be positive effects from firm's collaboration with universities and other knowledge actors.

In fact, in the above mentioned evaluation report on *"Videnkupon,"* a majority of the firms estimate a positive impact on their bottom line within three years. This signals that the firms perceive the collaboration to have a positive *outcome*, i.e. results that create opportunities for a firm, as well as potentially a positive *impact*, i.e. new knowledge generated from the collaboration contributes to the firm's performance (Pertuzé et al., 2010).

Moreover, the national or regional innovation systems are ecosystems of actors fulfilling different roles. Many of the 'external knowledge actors' (organizations and institutions) have individuals who are matchmaking firms and researchers at knowledge institutions, and therefore acting as 'middlemen' or intermediaries. *Innovation agents* is an example of this; there are 30-40 consultants at the nine GTS-institutes acting as innovation agents and are offering SMEs free 'innovation check-ups' and provide references to relevant knowledge sources and funding options[9].

In a report on 'matchmaking' in Denmark, several barriers have been identified as perceived by firms, as perceived by universities, and *relational barriers*; the latter includes 'different goals and expectations', 'different time horizons', and 'lack of flexible funding options' (F&I, 2008). Indeed, many of the reports and research that has been published over time has focused on *barriers* to collaboration between academia and industry (e.g., Bruneel et al., 2010; Tartari et al., 2012). A report published by the European Commission highlights the top three relational barriers, as perceived by academics and HEIs representatives: 'business lack awareness of HEI research activities/offerings', 'the limited absorption capacity of SMEs to take on internships or projects', and 'differing time horizons between HEI and business' (EC, 2011).

The study on the university-business cooperation (UBC) environment in 33 European countries also identified the *drivers* of UBC as perceived by academics and HEIs representative, including top three being 'existence of mutual trust', 'existence of mutual commitment', and 'having a shared goal' (EC, 2011). According to this study,

[9] Ministry of Higher Education and Science. Research and Innovation. Collaboration between research and innovation. Innovation Agents (2013): http://ufm.dk/en/research-and-innovation/cooperation-between-research-and-innovation/collaboration-between-research-and-industry/innovation-agents/innovation-agent

the drivers have a greater influence on UBC than the barriers; one could interpret this as the drivers can break through or overcome barriers. In fact, university-business cooperation can take many forms, and therefore the perceived drivers and barriers must differ across the various types of collaborative interaction.

The PhD study focuses primarily in the drivers and positive aspects of collaborative innovation between SMEs and academia. The research is conducted in the context of a Danish regional initative – a 3-year program (2011-2014) – called *'Genvej til Ny Viden.'* Operators and independent third parties in this program act as 'middlemen' and funding is provided to the collaborative innovation projects that are facilitated through program. Next section introduces the regional program, which is the central to this PhD dissertation.

1.4. Introducing a framework for facilitating SME-university collaboration[10]

This section introduces a regional program in the Central Region of Denmark with the aim to create growth through collaborative projects between SMEs (small and medium-sized firms) and academic researchers. The objective of the program is new knowledge creation to be absorbed into the SMEs. Moving beyond technology or knowledge transfer, existing knowledge from academia combined with practical knowledge for innovation solutions is the goal of this experimental regional program. Allocating an independent third party to facilitate the process and ensure interaction is part of the formalized and structured innovation process through which the actors undergo.

The Centre for Entrepreneurship and Innovation (CEI) at Aarhus University is the operator of this regional 3-year program (years 2011 to 2014). *Genvej til Ny Viden* is the name of the program – in English, *Shortcut to New Knowledge* – and is unprecedented in a Danish context. Throughout the PhD dissertation, the abbreviation 'GTNV-program' is used. The specific roles of the operator and independent third party is further investigated and described in the empirical research. The GTNV-model is managed and facilitated by the operators at a meta-level and can be compared to the stage-gate model (Cooper, 1990), as illustrated in the conceptual framework (*figure 1.1*).

There is a *perceived gap* between firms and universities, which is essentially rooted in differences between the two worlds. The GTNV-program is initiated to develop a

[10] This section is a newer version of a paper presented at the University-Industry Conference, Amsterdam, The Netherlands, May 27-29, 2013. Original paper is part of the Conference Proceedings: "Interactive learning in SME-university collaborations: A conceptual framework for facilitating interaction", in: *University-Industry Interaction: Challenges and Solutions for Fostering Entrepreneurial Universities and Collaborative Innovation*, Kliewe, T., Meerman, A, Baaken, T., and van der Sijde, P. (eds.), pp. 572-589. : University Industry Innovation Network.

model for managing and facilitating collaborations between SMEs and academic researchers in order to narrow the gap. The GTNV-program is an experimental program including approximately 30 SMEs completing the program, who had no prior experiences with collaborating with academic researcher (i.e., researchers with PhD degrees). Most of the firms have 50 or less employees.

A group of actors facilitates, at various levels, interaction between the two primary actors: SME and academic researcher. The group of facilitators contribute to each level of the interaction with a vision to create value and innovation from the applicability of academic knowledge in practical context in order to create new knowledge that is context-specific.

This group of actors includes:

a) the *project initiator* at the Central Region of Denmark (creates the opportunity and platform for collaborations);

b) the *operator*s at Centre for Entrepreneurship and Innovation (CEI) at Aarhus University (manage and coordinate the overall process for interactions at a meta-level); and,

c) the *independent third parties* (facilitate one or more innovation projects at a micro-level).

One of the expert interviewees[11] underlines one of the benefits, or outcomes, of firms when collaborating with acacemic researchers is the process of reaching a point where the firm acknowledges their 'unrecognized needs'. That is 'not knowing, what the firm does not know', and this recognition is affected positively by the university-industry interaction. Recognition is accelerated as the interaction with external knowledge sources expands the firm's absorptive capacity and to learn from acquiring external knowledge into the organization.

Additional benefits such as new products, concepts, services, processes are identified as tangible outcomes of the collaborations, which can be commercialized in a relative short-term perspective. Most SMEs operate with short-term horizons, therefore are fast implementations and tangibility of great important to SMEs. Value creating outcomes with medium or long-term perspective for the firms are newly acquired methods for collaboration, competence enhancement, and relationship-building with external actors. Other identified outcomes of the GTNV-model for long-term gain (and difficult to measure), is the value added attributes, such as the organizational changes including behavioral, organizational culture, influences on strategic level, and effective alterations to the firm's business model(s). In sum, SMEs are learning, as well as they learn to learn something new, when collaborating with academic researchers.

[11] See *Appendix E* for methods.

Furthermore, the operators of the GTNV-program have identified barriers and challenges to collaborations between SMEs and academia, and these are categorized as *system-based* and *human-based barriers.* Both types of barriers contribute to the *perceived gap* between university and firms. These are discussed in the literature review.

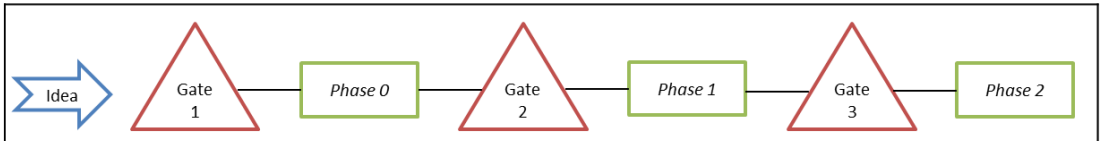
The operational framework for the university-industry collaboration or from a firm's perspective – SME-universty collaboration – is an example of a possible solution for creating knowledge flows between businesses and academia in order to overcome barriers, and thereby mitigate the perceived gap. The GTNV-program is a platform for collaborations as well as a framework to overcome system-based barriers through human interaction.

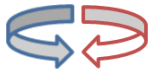
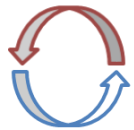
The ideal scenario is when the operator matches *professional competences* of the primary actors. Human interaction through direct communication and face-to-face meetings is necessary in order to identify whether *personalities* match to further relationship building. Therefore, the '*formula'* for overcoming some of the barriers for collaboration is arguably the matching of complementary professional competences and personalities, which in turn may lead to interpersonal relationship and ties between SME and academic researcher for further collaboration after the completion of the innovation project in the GTNV-program. Essentially, "Relations, relations, relations, relations!" is a key ingredient to university-industry interaction, as expressed by one of the operator, which is supported by the other operators' argumentation for human interaction being the *fundamental cornerstone* in these type of innovation projects.

Nevertheless, not all firms need academic knowledge – and not all academic knowledge resources may be applied into practice. In areas where the communication channels and collaboration is creating value for the interacting parts (including innovation and economic development for the region or at a national level), the framework for opening doors for collaborative innovation projects between SMEs and academia should be supported by incentives structures. Not only for the academic researchers but also for the SME – for instance funding opportunities. The GTNV-program does give SMEs the opportunity to apply for funding (similar to other national and EU innovation policies).

The GTNV-model is illustrated in *figure 1.5* as a conceptual framework for managing an innovation process between SMEs and academic researchers from a regional perspective. This abstract depiction of the process, which is applied empirically, is an illustration that draws parallels to the stage-gate approach for innovation processes (Cooper, 1990).

Figure 1.5. Conceptual framework for facilitating university-industry interaction, including an abstract illustration of human interaction narrowing the 'perceived gap' (next page).



	Initial screen	***Initial stage (preliminary assessment)***	**Second screen**	***Preparatory stage (detailed investigation)***	**Decision on innovation project**	***Completion stage (practical implementation)***
Main Actors	Operator	Operator SMEs	Operator	Operator SMEs Reseachers	Operator Expert panel	Intermediary SMEs Researchers (Operator)
Activities	Evaluate ideas and needs of the SME	Develop idea Sparring SMEs apply for phase 1 (+ funding)	Evaluate applications for phase 1	Matchmaking SMEs apply for phase 2 (+ funding)	Evaluation of applications to phase 2	Interactive learning SME-researcher collaboration managed by intermediary Monitored by operator
Perveiced Gap	SME approaching university 	Operator sparring on behalf of university 		Matchmaking SME and reseacher 		Interacting 

Explaining the processes with gates and phases in the conceptual framework (*figure 1.5*) that illustrates the perceived gap being narrow by the actor and activities in which they engage in. *Gate 1* is the initial screen where the SME approaches the university and the operator evaluates the idea(s) of the SME. Is the idea of the particular SME considered to be relevant and important in terms of a SME-university collaboration, for this type of collaborative innovation project, then the process moves in to *phase 0*, which is the intial stage for preliminary assessment, where the operator is sparring with the SME in order to further develop the idea from Gate 1. The SME completes an application to futher the process and apply for funding. At *Gate 2* (second screen), the operator evaluates the applications from the SMEs and select which firm may enter *Phase 1.*

In *Phase 1*, the preparatory stage and detailed investigation, the operator matches SMEs and one or more academic researchers. In this phase, the SME and academic researcher meet for the first time and collaborate for up to six months. During this interaction, the actors find out whether there is a *match* between their professional competences and personalities in order to further the collaboration. SMEs apply to enter the last phase of the process and to receive funding for their collaborative innovation project. The operator and an expert panel at *Gate 3* evaluate this application and decide whether to provide funding for the particular innovation project.

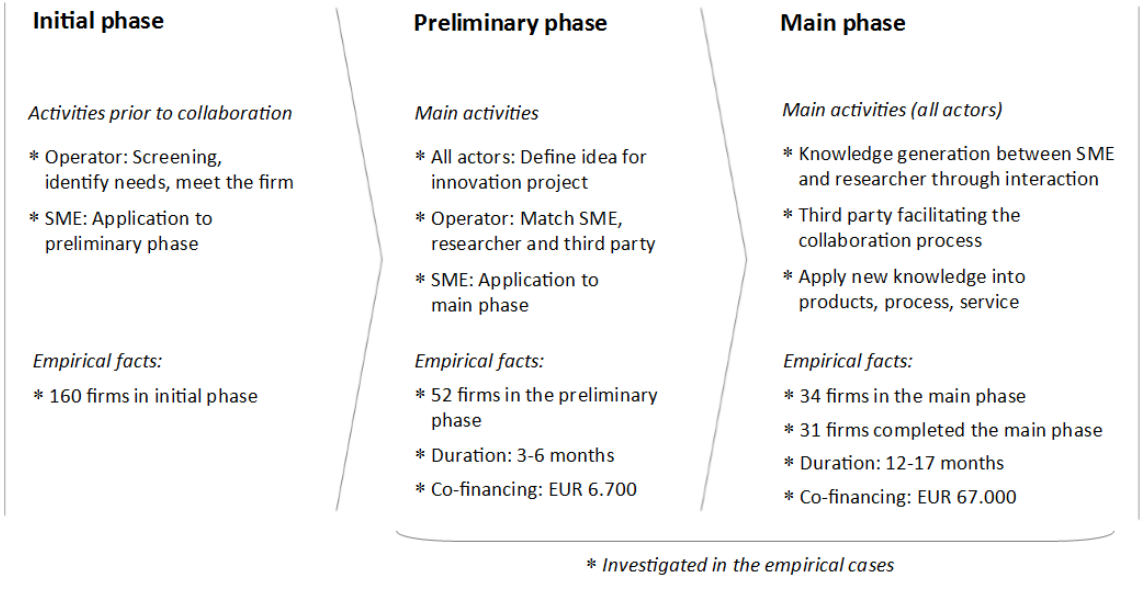
The main part of the process, where the two main actors – SME and academic researchers(s) – interact in their collaborative innovation project is in *Phase 2*. This phase represents the main activities of the project and is the completion stage with practical implementations. During this phase, most of the collaborative work, knowledge sharing and knowledge generation between an SME and the academic researcher(s) occurs. As *figure 1* illustrates, the *perceived gap* is mitigated through the phases of the process.

Futhermore, the collaboration is supported and managed by an independent third party – *intermediary* or *broker* – as well as monitored by the operator. The roles of the operator and the independent third party are studied in the empirical research part of the PhD dissertation.

The GTNV-model in *figure 1.6* is a simplified version of the conceptual framework in *figure 1.5*. It illustrates the three phases of GTNV-program: *initial phase* (phase 0), *preliminary phase* (Phase 1), and the *main phase* (Phase 2). Empirical facts such as number of firms, duration and co-financing (funding) is also outlined in *figure 1.6*.

A theoretical discussion of the conceptual framework (*figure 1.5*) is part of the literature review, and the GTNV-model (*figure 1.6*) is further developed and discussed in the empirical research part of the PhD dissertation.

Figure 1.6. The GTNV-model for collaborations between SMEs, academic researchers, and independent third party (next page).


Initial phase
Activities prior to collaboration
* Operator: Screening, identify needs, meet the firm
* SME: Application to preliminary phase
Empirical facts:
* 160 firms in initial phase
Preliminary phase
Main activities
* All actors: Define idea for innovation project
* Operator: Match SME, researcher and third party
* SME: Application to main phase
Empirical facts:
* 52 firms in the preliminary phase
* Duration: 3-6 months
* Co-financing: EUR 6.700
Main phase
Main activities (all actors)
* Knowledge generation between SME and researcher through interaction
* Third party facilitating the collaboration process
* Apply new knowledge into products, process, service
Empirical facts:
* 34 firms in the main phase
* 31 firms completed the main phase
* Duration: 12-17 months
* Co-financing: EUR 67.000
* Investigated in the empirical cases

Next section is an excerpt from a co-design workshop[12] conducted in the empirical research. It summarizes the participant discussion into key points that gives a better understanding of what collaborative innovation projects between SMEs and Academia are in this context, and it provides a good foundation for the empirical research.

1.5. Key points of collaborative innovation projects

This section aims to introduce 'what is being studied,' as in a summation of collaborative innovation projects into *key points.* Hence, the key points represent these projects as they are perceived, experienced and interpreted by the actors (SMEs, academic researcher and broker). Five themes emerged from interviews in the empirical research conducted in the PhD study, and these are outlined in *table 1.1*. The themes were discussed retrospectively by actors whom participated in workshop conducted towards the end of the PhD study.

The key points of the participant discussion are summarized in *table 1.1.* The key points to the theme cards 'Collaboration', 'Knowledge', and 'Innovation', are *combine practice and theoretical knowledge, knowledge is dynamic (not static), combination of existing knowledge – connecting bit and pieces*. These are arguably the characteristics of knowledge brokering; this is a process of combining existing knowledge in new contexts, which is the foundation for recombinant innovation.

Innovation has to make sense, value, or have purpose, as mentioned by the participants and this is descriptive of *strategic alignment*, found as a main driver in chapter 4. Some of the elements of the collaboration are described as including *making time* for the project (e.g., *time factor* as potential barrier), *willingness to change* (e.g., one of the main drivers). For the theme of 'dialogue and interaction' (e.g. *dialogue-based process* as a collaboration characteristic), *face-to-face interaction*, *mutual respect*, and *open to change* were discussed in the group and identified as *"interaction enablers"* in chapter 4.

In the empirical research, there is evidence that most of the knowledge sharing predominantly (and thus preferably) occurred through personal meetings – face-to-face. The Object Game, which is presented in chapter 6, highlighted this finding. When analyzing the *story-building* in the Object Game, the *story-cards* most often placed as the first card answering the question of '*how?*' was the *face-to-face* story-card. Nonetheless, six out of eight firms interviewed from the regional program answered (good) *chemistry* as being *crucial* in the collaboration with academic researchers.

[12] Co-design workshop is presented in *chapter 6*. Theme cards (in Danish) and participant discussion (in English) are part of the appendices.

Table 1.1. Key points of collaborative innovation projects:
Collaboration, Chemistry, Dialogue & interaction, Knowledge, and Innovation.

Themes	Key points
(Knowledge-based) Collaboration	▪ Reciprocal process (synergy) ▪ Knowledge flows both ways (reciprocity) ▪ Willingness, prioritizing it, and making time for it ▪ Combine practice and theoretical knowledge
Chemistry ***('good' chemistry)***	▪ Communication: talk to each other, understand each other ▪ Commitment ▪ Respect for disciplines (complementary competences) ▪ Respect for agreements ▪ Mutual respect
Dialogue & interaction	▪ Face-to-face is essential ▪ Open to change ▪ Readiness and willing to change ▪ Reciprocity in combining disciplines
Knowledge	▪ Value in the application of knowledge ▪ Knowledge is dynamic ▪ Knowledge in how things are done – systematic approach ▪ Comparing knowledge with other knowledge bases in the collaboration – and get recognition ▪ Willingness to share knowledge with others
Innovation	▪ Innovation has to make sense ▪ Willingness to run innovation projects ▪ Combination of existing knowledge – connecting bits and pieces (and learn something new) ▪ Aspect of change and something new ('nova') – and has to have value or purpose ▪ The driver: what you do has to have value – for someone ▪ No 'magical thinking' in innovation

Overall, the key points in *table 1.1* are very good descriptors of the collaborative innovation projects that these particular SMEs have experienced by collaborating with academic researchers throught the GTNV-program. The descriptors provide the researcher and reader with a good sense of the central ingredients of the actors' collaborations. It is a good foundational understanding of the context for the empirical research presented in this PhD study.

The following sections introduce the research objective and aims (1.6), scope of the research (1.7), research questions (1.8) and the structure of the PhD dissertation (1.9).

1.6. Research objective and aims

The PhD study was initiated by *Insero Horsens*[13] in 2012, and together with *Familien Hede Nielsens Fond*[14] they have financially supported this PhD project. Therefore, the outset for the PhD project were empirically motivated, as one of the drivers for initiating the project in the first place was to research how firms, especially SMEs, in the vicinity of Insero Horsens could create growth. Innovation is a source of growth, and exploring ways in which firms in the vicinity of Insero Horsens could pursue innovation that could lead to growth, is the underlying motivation for the PhD study.

One empirical study shows that *35 percent* of regional firms within the value chains of Energy and ICT want a closer innovation collaboration with universities and higher education institutions, as well as *35 percent* want a closer innovation collaboration with GTS-institutes[15]. How SMEs collaborate with external knowledge actors – universities and higher educational institutions – to create and implement something new (i.e., innovation) was, after preliminary research, chosen as the topic for this project.

Investigating the *'successful'* collaborations through innovation projects could lead to a better understanding of the drivers (and potential barriers) of firms recombining their knowledge and resource bases with those of academia. This reasoning inspired one of the sub-questions for research: "How does collaborative innovation take place between SMEs and Academia, and how do they combine their knowledge bases?"

Collaborative innovation projects, which is a core mechanism studied in the PhD project, are demand-driven collaborative projects between SMEs and academic researchers. This means, a firm has a need, an idea, or a problem to be solved, which demands knowledge and expertise from external sources, e.g. academia. Successful collaborative projects are investigated in order to gain an understanding of how SMEs collaborate with Academia in effective ways and essentially identify the positive aspects – the *drivers* – of demand-driven collaborations. The underlying assumption is that if firms focus on the negative aspects of collaborating with academic researchers – the *barriers* – then only a limited number of firms and SMEs will continue to engage in this type of collaborative project. However, if focus shifts

[13] The Foundation, Insero Horsens: http://inserohorsens.dk/
[14] The Foundation, Famillien Hede Nielsens Fond: http://www.hedenielsensfond.dk/
[15] Insero Horsens (formerly, Energi Horsens) (2010). *Vækst og udvikling – Rapport om initiativerne og strategien bag nye indsatsområder indenfor Energi og IKT erhvervene i Energi Horsens området.* Report by/Rapport udarbejdet af DAMVAD.

toward the positive aspects – the *drivers* – while being aware of *potential barriers*, then the power of 'the positive example' can drive more SMEs to collaborative with Academia.

In sum, the PhD project investigates collaborative innovation projects as a mechanism for integrating knowledge into the firm in the pursuit of (product, service, process) innovation. The people (brokers, CEOs/manager, academic researchers), processes (capabilities), and objects (boundary objects, objects-in-use) are investigated in order to gain an understanding of this phenomenon. The theoretical lens (*chapter 3*) focuses on exploring the roles of brokers, capabilities, and objects in the mechanism of collaborative innovation projects between SMEs and Academia, as managed and coordinated through the GTNV-program.

Identifying the role of (knowledge) brokers (e.g., Hargadon, 1998, 2002, 2003, 2014; Howells, 2006) and focusing on the role of different types of brokers in this context, gives an understanding of the roles of different individuals in collaborative projects. Investigating the underlying processes of how SMEs can build microfoundations of dynamic capabilities (i.e., sensing, seizing and transforming capabilities) defined as to create, modify, or extent their resource base (e.g. Teece, 2007; Helfat et al., 2007), help to explain why collaborative innovation projects are important for capability-building in SMEs. Additionally, the role of objects (e.g., Star and Griesemer, 1989; Carlile, 2002; Nicolini et al., 2012; Lindberg and Walter, 2013) in knowledge sharing processes between actors from different boundaries, aids our understanding of how objects facilitate knowledge flow between two (or more) knowledge bases. Gaining an understanding of the roles of brokers, capabilities, and objects in collaborative innovation projects will provide a more detailed description of how SMEs collaborate with Academia.

The idea to create a game, an exploratory design game (Brandt, 2006; Band et al., 2008, and Vaajakallio and Mattelmäki, 2014) called 'the Object Game,' came along the research process. It became an essential and integral part of the PhD study. As a research tool (for researchers) and reflective tool (for the collaborators), the Object Game has proven to be an important piece in the 'jigsaw puzzle' of how SMEs collaborate with Academia – and shaping *collaborative boundary practices.*

Ultimately, this research could result in a new way of defining SMEs' collaboration with Academia, which if acted upon, could lead to an increased number of SMEs engaging in collaborative innovation projects with Academia and other knowledge institutions. This would bridge the two knowledge bases – research and practical – to generate and transform knowledge into innovative product, services, or processes for the future economic growth in Denmark and beyond.

1.7. Scope of the research

The title of the dissertation is *How do SMEs collaborate with Academia?* And the sub-title is *Exploratory design game and the roles of brokers, capabilities, and objects in collaborative innovation projects.*

In short, the title is the central research question, and the three sub-questions related to the subtitle, with the aim of answering the main question of 'How do SMEs collaborate with Academia?' The empirical research is in the context of a Danish regional program (e.g., GTNV-program), which facilitates collaborative innovation projects between SMEs (primarily smaller firms) and academic researchers.

The title – and the central research question – is broad and empirical-based. The three sub-questions focus the research, and thus the scope. The objective is to investigate how knowledge flow for collaborative innovation occurs between the two knowledge bases. The mechanism studied is multiple collaborative innovation projects from a process-perspective, while focusing on the roles of brokers, capabilities, and objects.

The role of *brokers* – or independent third parties – in facilitating the interaction and knowledge sharing between the two primary actors (SME and Academia) is studied through the theoretical lens of knowledge brokers and knowledge brokering (e.g., Hargadon, 2003, 2014). The focus is on how knowledge is brokered, shared, and integrated in the firms' existing or new operational activities, through the assistance of independent external actors (e.g., broker).

Capabilities are viewed through the search and selection processes of SMEs, and the process of SMEs collaborating with external knowledge actors (academia) via the GTNV-program. More specifically, the microfoundations of dynamic managerial capabilities, e.g. sensing, seizing, and transforming (e.g., Helfat et al., 2007; Teece, 2007) built through collaborative innovation projects. In actuality, it is the context of projects, where individuals in SMEs (e.g., CEO, top managers, and project members) engage in innovation activities with individuals from Academia (e.g., academic researchers) and other organizations (e.g., brokers). However, during the PhD research, it became evident that dynamic capabilities are very difficult to observe empirically, and therefore part of the research is a conceptual discussion of what goes on empirically and how this might build the microfoundations of dynamic capabilities, in the firms, for knowledge sharing in collaborative innovation projects.

Objects used in the knowledge sharing processes in collaborative innovation projects are studied through the concepts of boundary objects (e.g., Star and Griesemer, 1989; Carlile, 2002; Nicolini et al., 2012) and objects-in-use, which are objects enacted into being (e.g., Law and Singleton, 2005; Lindberg and Walter, 2013), in order to gain an understanding of the objects used facilitate knowledge flow.

Overall, the scope of the PhD project is to describe, from a process-perspective and primarily from the firm's point of view, on how SMEs collaborate with Academia

through the mechanism of projects facilitated by the GTNV-program in order to make knowledge flow for collaborative innovation. The following section outlines the central research question and three sub-questions on brokers, capabilities, and objects. However, in order to answer each question, the understanding of the roles combined is essential to describing how SMEs collaborate with Academia.

1.8. Research questions

The key assumption in the PhD study is that combining the knowledge bases of firms and academia will lead to a positive *outcome*, with a potential *impact* on the firm, if the outcome is integrated. This is *why* the PhD study addresses the collaboration between SMEs and Academia. The central question addresses *how* this is achieved, and thus implies studying the process of collaboration between the two actors:

How do SMEs collaborate with Academia?

The central research question is broad and empirically grounded. The three sub-questions narrow the research scope by focusing on the roles of brokers, capabilities, and objects in the empirical setting and mechanism of collaborative innovation projects. The first sub-question is:

How does collaborative innovation take place between SMEs and Academia, and how do they combine their knowledge bases?

This question addresses the innovation process through the firms' collaboration with external knowledge actors (academic researchers). To answer this question, we need to explore and understand the roles of brokers, capabilities and objects in the mechanism of collaborative innovation projects. Elements of the collaborative innovation projects are explored to gain an understanding of how the two actors combine their knowledge bases, with the assistance of brokers, for a (potential) innovative *outcome* (e.g., product, service, or process innovation). The microfoundations of dynamic capabilities are discussed conceptually since observing these capabilities in the empirical settings has proven to be difficult, if not impossible. The second sub-question is on brokers:

What is the role of brokers in collaborative innovation projects?

Being able to answer how SMEs collaborate with Academia, and how collaborative innovation takes place by combining the two knowledge bases, we need to explore the roles of people involved in these processes, especially the brokers in this concext. Identifying the role of brokers – and different types of brokers – aids our understanding of how brokers facilitate collaborative innovation between SMEs and academic researchers. The third sub-question is on objects:

What types of objects facilitate the knowledge sharing process – and how?

When people engage in processes, objects are an inevitable part of the setting. Exploring the role of objects used in the collaborative innovation projects, and how these objects facilitate different types of knowledge flows, helps us understand what types of objects facilitate knowledge sharing, and how they have been used by the collaborators. To discover this, an exploratory design game called the *Object Game* is developed and used in a co-design workshop – as a research tool and a reflective tool.

The three sub-questions focus on different aspects on how SMEs collaborate with Academia, and do so by exploring the interconnectedness between *people*, *processes* and *things*. Exploring the roles of brokers, capabilities, objects and design game in this context shapes our understanding on a new collaborative boundary practice for how knowledge can flow between knowledge bases and how collaborative innovation can take place between SMEs and Academia.

1.9. The structure of the dissertation

The dissertation is divided in four parts*: Part I. Introduction, Part II. Literature review, Part III. Empirical research*, and the conclusions in *Part IV. How do SMEs collaborate with Academia?*.

PART I – INTRODUCTION

Chapter 1. Introduction

This chapter introduces the research area and empirical context. The chapter gives an overview of collaborative innovation in Denmark, policies, and presentation of the empirical framework for the research, the GTNV-program, as well as a brief introduction to what collaborative innovation projects are as summarized into key points. Furthermore, the foundations of the research including problem statement, the objectives and aims of the study, research scope, and research questions are presented.

Chapter 2. Research approach

In this chapter, the approach with research design, methods, sources of data, and role of the researcher are outlined and discussed. The different cases are presented, as well as how the pilot study (Appendix B) and the lessons learned from this study has shaped the research process.

PART II – LITERATURE REVIEW

Chapter 3. Theoretical lens

This chapter is a conceptual review of the vast literatures on Innovation through collaboration (*collaborative innovation*), Dynamic *capabilities*, Knowledge *brokers*, and Boundary *objects*, and design games. The theoretical lens focuses on describing what goes on empirically by exploring the roles of brokers, capabilities, and objects in collaborative innovation projects – and shaping a (new) *collaborative boundary practice*.

PART III – EMPIRICAL RESEARCH

Chapter 4. Interaction enablers, drivers and barriers of collaborative innovation projects between small firms and academia

This chapter is an article published in *Danish Journal of Management & Business, nr. 1, 2016.* The article focuses on the role of brokers and the distinction between two types of brokers in the GTNV-program. Elements of collaborative innovation projects between small firms and academia are identified and categorized into *interaction enablers, collaboration characteristics, main drivers,* and *main barriers.* The *broker of human interaction* is introduced in this part of the empirical research.

Chapter 5. Building microfoundations of dynamic capabilities for knowledge sharing in collaborative innovation projects

This chapter is a conceptual discussion on how firms build microfoundations of sensing, seizing and transforming capabilities by engaging in collaborative innovation projects with academic researchers. The GTNV-model presented in the introduction and chapter 4, is developed into a process model, which links dynamic capabilities to key concepts within innovation management and knowledge management: *Process model of dynamic capabilities for knowledge sharing in collaborative innovation projects*.

Chapter 6. Designing the Object Game: Collaborative reflections and knowledge sharing in action

This chapter is a practical paper describing the process of developing and designing the *Object Game* – an exploratory design game functioning as boundary object. The Object Game is a research tool and reflective tool used in a co-design workshop, where the participants engage in a dialogue and reflection on their collaborative innovation projects, while exploring the role of objects. The chapter shows and describes the game materials and how it is used in action.

Chapter 7. The role of objects in collaborative innovation projects

This chapter is an exploration into the role of objects. The *Object Game* functions as a research tool in exploring how objects have been used in practice, and how these objects facilitate different types of knowledge flows – *transfer, exchange, generation,* and *integration.* A descriptive classification of objects – *four S' of objects-in-use* – is developed with definitions and examples, and discussed in relation to their roles in collaborative innovation projects.

PART IV – HOW DO SMEs COLLABORATE WITH ACADEMIA?

Chapter 8. Conclusion and key takeaways

This concluding chapter outlines the key takeaways from the empirical research and shaping *collaborative boundary practices*. The chapter includes sections with concluding answers to research questions, academic contributions and suggestions for further research, as well as contributions to practice and policy.

Chapter 2. Research approach

In the beginning of the PhD project, the research could go in many directions when studying how small and medium-sized firms (SMEs) can create growth. When pursuing my bachelor's degree in business administration, global strategy and strategic management were research areas that caught my interest, and later during my master's degree in international business, business models and innovation management inspired me. The latter quickly became a subject of interest when studying how firm could create growth – innovation and change. Change is an element of innovation, but not all changes lead to innovation.

Innovation can occur through 'open' processes between firms and external actors, and this became the main context in which the PhD research should be conducted: university-industry collaboration. Knowledge is an essential part of innovation, and combining different types of knowledge, such as knowledge bases of firms and academia, respectively, in theory this could lead to innovation. Innovation can lead to growth, so when studying the body of literature of dynamic capabilities, it became evident that this had to be investigated empirically. In other word, investigate how SMEs combine their knowledge with that of Academia in order to create something new, create change – to innovate. Dynamic capabilities addresses the need to reconfigure resources, including knowledge as a resource, to effectuate strategic change for long-term survival or competitive advantage. No doubt, dynamic capabilities had to be one of the main areas of focus in the PhD study.

The process of combining two or more existing knowledge bases between different actors has, in some way, to be managed by 'someone' – internally or externally. Studying the body of literature on intermediaries and knowledge brokers, this was a very interesting subject to be studied within the context of university-industry collaborations. The nature of the collaboration can be innovation – Open innovation or Collaborative innovation – and thus innovation processes. Knowledge brokers engage in brokering activities where knowledge is moved from one 'world' to another and combined into recombinant innovation.

At first, the focus was on brokers who plays a role in the innovation process where knowledge between firms and external actors is combined, and thus used as a resource in the firm. An important resource that can help the firm create change and growth. Along the research process, it became clear that knowledge is not only combined with the help of actors – internal and/or external people – but also through different means, such as objects. Knowledge does not only flow with people, but also via objects, or as a combination of people and objects. This area of objects and their role had to be explored further. Learning about design games at a PhD course and how these could facilitate a different type of dialogue between actors (people), it became the seed of inspiration to pursue developing a game with the

specific purpose: to explore the role of objects in collaborative innovation projects between SMEs and academia researchers.

Although this PhD project could have gone in any direction when studying the context of university-industry collaboration through the lens of innovation management, the sequence of events during the initial stages of the research process inevitably led to exploring the roles of brokers, capabilities, and objects in the mechanism of collaborative innovation projects. One of these 'events' is the pilot study (*Appendix B*), which guided the research focus towards a structure where the three areas of focus could be studied in an empirical setting – the GTNV-program. What was learned in the pilot study and how it guided the research process is explained in *subsection 2.4.3*.

The next section discusses the qualitative research conducted in the PhD project, and presents the research approach as a plan to conduct research, which includes connecting worldviews (i.e., paradigm), research design, and specific research methods (e.g., Creswell, 2014).

2.1. Qualitative research: Worldviews, research design, and research methods

The PhD project is an exploratory study based primarily on qualitative research, which is "an approach for exploring and understanding the meaning of individuals or groups ascribe to a social or human problem" (Creswell, 2014; 4). Qualitative research uses predominantly words and open-ended questions, where the researcher makes interpretations of the meaning of the data, whereas quantitative research is based on numbers and closed-ended questions (Creswell, 2014). The interview guides for the qualitative interviews with open-ended questions are included in the Appendices.

The qualitative research in this study follows an inductive style (i.e., induction), which focuses on individual meaning and the complexity of a situation, unlike quantitative research which tests theories deductively (i.e. deduction) (Creswell, 2014). In induction, known premises are used to generate untested conclusions on data exploring a phenomenon to identify themes and patterns in order to create a conceptual framework – with generalization going from the specific to the general – for theory generation and building (Saunders et al., 2012). In deduction, when the premises are true, the conclusions must also be true; this is based on data collection strategies to evaluate hypothesis or propositions related to an existing theory – with generalization going from general to specific – for theory falsification or verification (Saunders et al., 2012).

The chosen methodology shapes the research activities in the empirical setting such that the questions asked in the qualitative interviews are open-ended to match the inductive approach, which focuses on the meaning and interpretation of data to identify themes and patterns. This research activity is complemented by testing how objects facilitate knowledge flows in collaborative innovation projects, and thus following an abductive approach.

In abduction, known premises are used to generate testable conclusions on data exploring a phenomenon to identify themes and patterns, locating these in a conceptual framework and testing this through further data collection, and repeating this (Saunders et al. 2012). With generalization, this goes from the interactions between the specific and the general – for theory generation or modification, as well as incorporating existing theory – in order to modify existing theory or build new theory (Saunders et al., 2012).

Dubois and Gadde (2002) introduce 'systematic combining', which builds on an abductive logic. Abduction is thus a process of going back and forth between theory and data; deduction is moving from theory to data, whereas induction is moving from data to theory (Saunders et al., 2012). According to Saunders et al. (2012), abduction "matches what many business and management researchers actually do" (p. 115). As the authors state, "Abduction begins with the observation of a 'surprising fact'; it then works out a plausible theory of how this could have occurred" (Saunders et al., 2012; 115). There is a risk in following an inductive or abductive style, as there potentially is no useful data patterns or no theory will emerge (Saunders et al., 2012). The abductive approach followed in a workshop setting, where objects identified in the case studies are used as game materials in an exploratory design game in order to explore how objects facilitate knowledge flows.

The view of the researcher in interpreting the qualitative data from interviews and workshop setting is evidently shaped by the worldviews through which the data is perceived. There are four philosophical worldviews, or research paradigms, which guide action in research: Postpositivism, Constructivism, Transformative, Pragmatism (Creswell, 2014). Constructivism is a typical approach in qualitative research, unlike quantitative research that is positioned within the postpositivist worldview, and mixed methods research is typically positioned within the pragmatic worldview (Creswell, 2014).

The research conducted in the PhD project is within the constructivist worldview – social constructivism – which is often combined with interpretivism (Creswell, 2014). Constructivism is a subjective view on the world, where "social phenomena are created from the perceptions and consequent actions of social actors" (Saunders et al., 2012; 100). In the study of management, a subjectivist view considers the way managers themselves attach their own meanings to certain activities, more important in order to understand social phenomena (Saunders et al., 2012).

Creswell (2014) describes case studies as a design on inquiry in which the researcher develops an in-depth analysis of a case or several cases, which are often an event, activity, program, or process; these are all bounded by time and some kind of activity. The qualitative research design chosen is based on case studies, where the meaning of activities, in which the actors engage in, is from a subjective view of their own experiences. In the empirical research as case study is a collaborative innovation project, thus the level of analysis is at project-level.

Through case studies, the researcher interprets the data in order to comprehend the meaning of text or action (Miles and Huberman, 1994). In case studies, collecting information is obtained by using a variety of data collection procedures (Creswell, 2014), which are addressed in a next section. The following subsection discusses the role of the researcher and how the researchers choices shape the research activities, interpretation of data, and thus also the findings.

2.1.1. Role of the researcher

The researcher's role is to gain a systemic, encompassing, integrated – a holistic – overview of the context under study, where the researcher is the main 'measurement device' (Miles and Huberman, 1994). The constructivist researcher seeks to understand the world in which other individuals live and work in, and often addressing the processes of interaction among individuals, with the overall intent of making sense of – or interpreting – the meanings others have about a phenomenon or situation (Creswell, 2014). The motivation for this PhD project is grounded in Insero Horsens' (The Foundation) aim to explore ways on how firms in the vicinity could achieve growth through different means. As previously presented in *chapter 1*, a study conducted by a third party showed that many firms in the vicinity of Insero wanted a closer innovation collaboration with knowledge institutions, and this could potentially be one of the 'means' in which growth could be achieved. Therefore, a selection of 'successful' collaborations were investigated to gain an understanding of the drivers and potential barriers to such collaborations.

The researcher takes part in the construction of knowledge through conversations with individuals in research interviews (Kvale and Brinkmann, 2009) and is hence an active interpreter, both during the conversation and in the analysis of interview data. Nonetheless, qualitative research is interpretive research (Creswell, 2014). The personal background of the researcher may shape the directions of the study and potentially shape interpretations, such as selection of themes and the meaning ascribed to data (Creswell, 2014). The author of this dissertation has an educational background in business and management, with a bachelor's degree in Business Administration and specialization in International Business, and a master's degree in Economics and Business Administration with a specialization in International Business. Inevitably, this has an impact on the choices made in the research conducted and focus areas of the study. Collaboration between firms and academia

may be studied in a variety of ways, including incentives structures for academic researchers to engage in collaboration with industry, study the different types of collaboration, and mobility of staff between industry and academia. Additionally, the role of students in linking academia and industry, the role of the entrepreneurial university, the role of innovation policies, the formation of clusters with various actors, and so forth, could also have been focus areas of this type of study. The process of choosing and focusing on brokers, capabilities, and objects was described in the introduction paragraphs to this chapter.

Reflecting on the research process, the researcher's background, and specially the academic interest, has shaped the core of the research conducted. This is predominantly the focus on collaborative innovation between SMEs and academic researchers and in exploring the roles of brokers, capabilities, and objects in an empirical setting. A firm-perspective on the SME's collaboration with Academia is thus also a reflection of the researchers background, as well as the motivation behind the PhD project.

Gaining entry to a specific setting to study the participants or a given situation is also part of the researcher's role (Creswell, 2014). Although two foundations funded this PhD project, the study is not conducted as a 'backyard research'; the data for the PhD study is obtained outside the boundaries of Insero Horsens and Insero Group. The primary source of data for the empirical research is the Danish regional program, GTNV-program (*Shortcut to New Knowledge*), where SMEs collaborate with academic researchers and third parties (brokers) to create knowledge for future growth in the firms. The researcher gained access to interview data and document data by contacting the Project Manager and initiating a collaboration that resulted in co-authored papers. Interviews for three of the case studies were conducted subsequently, after gaining access to potential cases, and resulted in the development and design of the Object Game, which was applied in a workshop with of two of these three cases. The idea of developing a game originated from participating in the PhD course on 'Innovation Processes and Their Staging', as the author of this dissertation was inspired by other examples and through the contact with guest lecturer, who then later became a co-creator and co-author on the paper about the Object Game (*chapter 6*).

The following sections describes the data selection processes, data collection procedures, including techniques and sources of data, followed by a section on data analysis that presents the case studies conducted in the PhD project.

2.2. Data selection

The main driver of data selection was the motivation behind the PhD project: exploring how SMEs collaborate with Academia through collaborative innovation projects to create growth – in the firm and region. Therefore, the data collection strategy was to obtain information on 'successful' collaborative innovation projects between SMEs and academic researchers – collaborations that have been assisted by brokers in a certain context. One context in which this occurred with several firms at the same time was through the regional program – *Shortcut to New Knowledge*. *Chapter 1* introduced the GTNV-program and its model is further developed in the empirical research.

Selecting the 'successful' collaboration is an information-oriented selection of case based on the expectation of information content (e.g, Flyvbjerg, 2006). From the data collection in the pilot study (*appendix B*) to the cases in the GTNV-program, the sampling strategy is a mix of 'snowball or chain' and 'intensity'. The *snowball* or *chain* strategy "identifies cases of interest from people who know people who know what cases are information-rich," and *intensity* is "information-rich cases that manifest the phenomenon intensely, but not extremely" (Miles and Huberman, 1994; 28). According to Miles and Huberman (1994), these strategies benefit inductive, theory-building analysis.

In this context, 'successful' means that the particular firm in question has completed the program (three-phase process) and thereby has showed willingness and abilities to collaborate with academic researcher, in order to solve a specific problem in the firm. Hence the cases selected, directly and indirectly, touch upon the positive aspects of collaborative innovation, as these are 'successful' cases, rather than focusing on the cases that did not complete the program, which arguably would have focused on the negative aspects of the collaboration. In other words, the selected cases dig into the elements that drive this type of collaboration, whereas a study of negative elements would have focused on 'what went wrong' – or the barriers to collaboration. Nonetheless, both types of studies are important.

Due to time and resource restrictions, a handful of 'successful' cases can only be studied after the collaborators have completed the phases of the GTNV-program. This affects the research activities and choice of techniques for collecting data. Following and observing collaborations first hand is a technique for inquiring unfiltered data, however this is time consuming, and the researcher cannot know beforehand whether a collaboration will be a success or not. Qualitative interviews are most often retrospective and thus a useful and timesaving technique in exploring the processes of successful collaborations. However, some details about the collaboration may be unclear or lost due to key informants have difficulties remembering all aspects of the process, as well as the data acquired has been filtered by the interviewee. Therefore, the data selection strategies not only affect the research activities, but also has an impact on the type of data collected.

2.3. Data collection

The main idea behind qualitative research is identifying and purposefully selecting the setting and key informants (individuals) that will best help the researcher understand the problem, and not random sampling or large numbers of participants, as is typical in quantitative research (Creswell, 2014). The data collection strategy of the empirical research is to collect information through case studies by applying the technique of qualitative interviews as the primary data collection method. In the empirical research, a case study is considered to be 'one collaborative innovation project' between SME and academic researcher(s).

Case studies is the main research method in the PhD study. The *how* and *why* questions are addressed in case studies, which provide rich, descriptive evidence on particular instances of a phenomenon, and are based on a variety of data sources (Yin, 1994). According to Dubois and Gadde (2002), "Case studies provide unique means of developing theory by utilizing in-depth insights of empirical phenomena and their contexts" (p. 555).

However, Dubois and Gadde criticize textbooks on research methodologies, which tend to describe case studies as a linear process and fail to account for the opportunities offered by an integrated approach enabled by case research (2002). Dubois and Gadde claim, "The main objective of any research is to confront theory with the empirical world" (2002; 555). Examples of rather linear case research procedures include the eight-step process by Eisenhardt (1989) for inductively building theories, and the case study methods described by Yin (2009) that are based on replication logic, in contrast to sampling logic in surveys of quantitative research.

Table 2.1 gives an overview of the methods and sources of data. The data collection process in the empirical research part of this PhD dissertation is threefold with case studies within GNTV-program. Five case studies, followed by three case studies, and findings of objects were tested in a co-design workshop with the use of an exploratory design game in order to spark dialogue between the collaborators in two cases (of the last three case studies).

This threefold process may seem rather linear, but the findings from the five case studies are supplemented with three cases, where the finding from all eight case studies are integrated into the exploratory design game developed for the specific purposes of gathering data on objects in collaborative innovation projects.

Furthermore, *table 2.1* also outlines data collected for the pilot study, which included interviews and documents, and methods applied in *Sections 1.2* and *1.4* (described in *Appendix E*). The appendices contain descriptive data on the SMEs in the multiple case studies (*Appendix A*), interview guides (in Danish) in *Appendix C*, and items of the Object Game in *Appendix H*.

Table 2.1. Overview: Methods and sources of data

Chapters / Sections	Methods and sources of data	Level of analysis	Time period (analysis)
Chapters 4, 5, 6, 7	5 case studies (Cases *Delta* to *Theta*): ▪ 20 in-depth, semi-structured interviews with 19 key informants (SME, academia, broker) (approx. 22 hours) ▪ Documents	Project-level	Fall 2014 Winter 2015
Chapters 6, 7	3 case studies (Cases *Alpha* to *Gamma*): ▪ 6 in-depth, semi-structured interviews with 6 key informants (SME, academia, broker) (approx. 4.5 hours) ▪ Documents	Project-level	Winter / Spring 2015
Chapters 6, 7 & Section 1.5 (chapter 1)	Workshop with 2 cases (Cases *Alpha* and *Beta*): ▪ Object Game (exploratory design game) ▪ Tuning-in session (with theme cards) Participants: CEO, Creative Director, academic researcher, broker (approx. 3 hours)	Project-level	Summer / Fall 2015
Appendix B (pilot study)	Case study (Case *Alpha Bakery*): ▪ In-depth, semi-structured interviews with 3 key informants (CEO, COO, Innovation Manager) (approx. 2.5 hours) ▪ Documents	Firm-level	Spring / Summer 2014
Section 1.4 (chapter 1)	Case study: ▪ 4 expert interviews (approx. 3.5 hours) ▪ Documents	Program-level	Winter / Spring 2013
Section 1.2 (chapter 1)	Statistical data: Community Innovation Survey, Denmark 2008-2010	Firm-level	Fall 2013

Table 2.1 shows that eight case studies (at project-level) and a design game is applied as research methods in the empirical research (*chapters 4, 5, 6,* and *7*). Creswell (2014) found, based on a review of many qualitative studies, that research on case studies include about four to five cases. Moreover, it is possible to learn from sample of one (March et al., 1991) and to generalize on the basis of a single case, as it may have 'the force of example' (Flyvbjerg, 2006).

There are pros and cons when conducting few or many case studies, as the researcher needs to consider the richness of data presented. Conducting a single-case study presents the researcher with the possibility to present rich qualitative data in form of narratives and quotations from key informants to show the close connection between empirical evidence and emerging theory (Eisenhardt and Graebner, 2007). However, the trade-off between theory and empirical richness poses a challenge for multiple-case researchers writing journal articles to stay within the spatial constraints, but this can be mitigated, to a certain extent, by providing summary tables (Eisenhardt and Graebner, 2007). The findings in the case studies are presented in summary tables in the empirical research.

However, it is difficult to summarize case studies especially 'case process', but less difficult to summarize 'case outcomes' (Flyvbjerg, 2006). Flyvbjerg (2006) claims, when addressing the five misunderstandings of case-study research, that "Often it is not desirable to summarize and generalize case studies. Good studies should be read as narratives in their entirety" (p. 241). This is somewhat addressed in presenting the study as images taken from the outcome of the *Object Game* in a workshop setting.

Nevertheless, multiple case studies typically provide a stronger base for theory building, and thus the theory is more robust, generalizable and testable, than in single-case research (Yin, 1994; Eisenhardt and Graebner, 2007). The reason behind this, is that multiple cases are chosen for their contributions to theory development within the set of cases (Eisenhardt and Graebner, 2007), and for theoretical reasons, including replication, extension of theory, or elimination of alternative explanations (Yin, 1994). Christensen (2006) describes the theory-building process as two-staged: the descriptive stage and the normative stage. Building descriptive theory is based on the three steps of observation, categorization, and association; building normative theory follows the same three steps, moving from the descriptive stage to normative through 'careful field-based research', and moving "beyond statements of correlation to define what causes the outcome of interest" (Christensen, 2006; 42). According to Christensen, "normative theory has much greater predictive power than descriptive theory does" (2006; 42).

The qualitative research conducted in the empirical research part of this PhD dissertation is, predominantly, in the descriptive stage. Studying the processes of collaborative innovation projects in the formalized structure of the GTNV-program cannot define exactly what causes these collaborations to be 'successful'; they are perceived as successful because they have completed the phases of GTNV-program, and the SMEs claim they would want to collaborate with academic researchers again

(or already have engaged in new projects with academia). However, there are many variables that can lead to success – in this PhD study – the focus is on the roles of brokers, capabilities, and objects, which are only some 'variables' in the greater scheme of the complex processes of innovation and interaction between actors.

Nonetheless, 'systematic combining', which is an integrated approach based on a logic of abduction, has the strength of confronting theory with empirical data and vice versa, as well as more or less, throughout the research process (Dubois and Gadde, 2002); the research process with the eight case studies attempts to emulate this. Findings from the case studies are integrated in the research tool developed for the purposes of exploring and testing how objects have been used in the case studies. This method for qualitative data inquiry thus follows an abductive logic in the collection and analysis of data. The following two subsections address the techniques applied and the sources of data, and this is further described in the subsequent section of data analysis.

2.3.1. Data collection techniques

Within the qualitative research, case study research is a strategy that can be conducted with a variety of techniques, including observations, interviews, and documents (Creswell, 2014). The PhD study is primarily based on the interview technique in collecting data, since "Interviews are a highly efficient way to gather rich, empirical data, especially when the phenomenon of interest is highly episodic and infrequent" (Eisenhardt and Graebner, 2007; 28). In a qualitative research interview, knowledge is constructed in the interaction between the interviewer and the interviewee, which essentially is "an inter-change of views between two persons conversing about a theme of mutual interest" (Kvale and Brinkmann, 2009; 2). The purpose of qualitative research interviews is to produce knowledge (Kvale and Brinkmann, 2009). According to Kvale and Brinkmann, "The qualitative research interview attempts to understand the world from the subjects' point of view, to unfold the meaning of their experiences, to uncover their lived world prior to scientific explanations" (2009; 1).

The seven practical steps in interview investigation, as recommended by Kvale and Brinkmann (2009), were followed: 1) thematizing an interview project, 2) designing, 3) interviewing, 4) transcribing, 5) analyzing, 6) verifying, and 7) reporting. The type of research interview applied in the PhD study is the semi-structured interview, which has "the purpose of obtaining descriptions of life world of the interviewee in order to interpret the meaning of the described phenomena", and can have explorative or hypothesis-testing purposes (Kvale and Brinkmann, 2009; 3). Interview research has few standard rules and is thus a craft that can become an art, if carried out well (Kvale and Brinkmann, 2009). In the PhD study, exploratory semi-structured interviews with open-ended questions were conducted following an interview guide. These were applied in personal, face-to-face interviews. The

duration of the interviews carried out ranged from 30 minutes (a couple) to more than 1.5 hours, but the majority were approximately one hour of duration. All interviews carried out by the author of the dissertation, co-authors and research colleagues (at Center for Entrepreneurship and Innovation, Aarhus University), were recorded and transcribed (extensively or word-for-word).

As described by Kvale and Brinkmann, "Reading transcribed interviews may inspire the researcher to new interpretations of well-known phenomena" (2009; 15). As previsouly mentioned, the interview data in the case studies were integrated into the design game, which led to new insights on the role of different objects used in the case studies. The author of this PhD disserationa and the co-author (of *chapter 6*) designed a tool – an exploratory design game – called the *Object Game.* The purpose of this was to gain an understanding of how the actors have shared knowledge in their collaborative innovation projects. Through the game pieces and a board, the actors engaged in dialogue and thereby reflected upon their collaboration and knowledge sharing by using different objects. Visual (photographs) and audiovisual (video) documents, as well as audio recordings were gathered throughout the workshop that lasted approximately 3 hours and included the collaborators from two of the eight case studies (i.e., *Alpha* and *Beta*).

2.3.2. Sources of data

The core of the PhD project includes multiple case studies – in total eight cases in the empirical research (*Alpha-Theta*). The eight case studies were all part of the regional program, and thus the eight cases selected have been part of and completed the three-phased process of the program. The author of this dissertation collected interview data for the empirical research in the following cases: *Alpha Bakery, Alpha, Beta,* and *Gamma*. Co-authors and research colleagues at Center for Entrepreneurship and Innovation, Aarhus University, collected interview data in cases *Delta, Epsilon, Zeta, Eta,* and *Theta*.

Table 2.1 outlines the amount of interviews conducted in the first round of interviews (five case studies, *Delta-Theta*) and in the second round (three case studies, *Alpha-Gamma*)[16]. An overview of the cases is presented in *table 2.2* with key informants, number of interviews and number of hours spent on data collection[17]. Prior to researching the cases within the framework of the GTNV-program, a pilot study was conducted, which is a case study on Alpha Bakery, and innovative manufacturing SME that was willing to share their experiences on how they search external knowledge and how they collaborate with external knowledge actors[18].

[16] This is also illustrated in *chapter 6,* see *figure 2*.
[17] Some key informants have been interviewed twice, and in *table 2.2 (# of interviews)*, a group interview with two respondents or more is listed as one interview.
[18] The pilot study is part of the Appendices – in *Appendix B.* How this case study informed and guided the research process is explained in subsection *2.4.3* and in *Appendix B.*

Table 2.2. Empirical research data

Case	Position or *Role* of key informants	# of interviews	# of hours (approx.)
Alpha Bakery (pilot study)	▪ CEO (owner) ▪ COO ▪ Innovation Manager	2 (and warm-up + follow-up questionnaires)	2.5
Alpha	▪ CEO ▪ Senior Project Manager, *Broker* (private sector) ▪ Two production workers	4 (and workshop)	2 (interviews) 3 (workshop)
Beta	▪ Creative Director (owner) ▪ Professor	1 (and workshop)	1.5 (interview) 3 (workshop)
Gamma	▪ CEO	1	1
Delta	▪ CEO (owner) ▪ Project Development Coordinator ▪ Associate Professor ▪ Innovation Advisor, *Broker* (knowledge institution)	4	4.5
Epsilon	▪ CEO ▪ Professor ▪ Business Consultant, *Broker* (public sector)	4	4.5
Zeta	▪ CEO (co-owner) ▪ Co-owner ▪ Associate Professor ▪ Researcher ▪ Senior Project Manager, *Broker*	4	5
Eta	▪ CEO (owner) ▪ Professor ▪ Consultant, *Broker* (knowledge institution)	4	4
Theta	▪ Business Developer (internal project coordinator) ▪ CEO (owner) ▪ Associate Professor ▪ Head of Innovation, *Broker* (knowledge institution)	4	4
Total	*29*	*28*	*32*

2.4. Data analysis

The analysis of qualitative data collected in interviews and documents of the multiple case studies follows the recommendation in qualitative research. For content analysis and within-case analysis, making tables with interview data, and thereafter comparing and contrasting the data across cases (i.e., cross-case analysis), is a useful approach for identifying common and unique patterns (Miles and Huberman, 1994).

In the PhD study, findings of the data analysis is provided in tables that summarize the patterns identified in the multiple case studies (*chapters 4* and *5*). Images and recordings from the workshop (*chapter 6*) is qualitative data that is analyzed through conversation and interaction analysis, in which a 'meaning' of a given object emerges from the dialogue facilitated by the game pieces (e.g., Buur and Larsen, 2010). *Table 2.3* is an overview of the data analysis in the multiple case studies and workshop setting.

There are different types of *validity* is qualitative research. Miles and Huberman draw on the work of Maxwell when discussing *internal validity* of a (case) study and understandings that may emerge (1994; 278):

- *'descriptive'* (what happened in specific situations);
- *'interpretive'* (what it meant to the people involved);
- *'theoretical'* (concepts, and their relationships, used to explain actions and meanings); and,
- *'evaluative'* (judgments of the worth or value of actions and meanings).

Several of these may emerge from the qualitative data. In the empirical research of the PhD study, the understandings in the data analyzed from the interviews included *descriptive*, as in what happened in the collaborative innovation projects, and *interpretive* that is what the process of collaboration meant to the people involved in these projects. In addition, concepts from different fields of research is used in order to explain the actions within the collaborative innovation projects (project-level) and in the GTNV-model (program-level), and therefore *theoretical* understanding emerged in the multiple case studies.

It may be argued that an *evaluative* understanding emerged from the data obtained in the workshop setting – with the use of the exploratory design game. The value of actions and meanings of objects used in certain actions are judged by the participants, as well as the research and reflective tool's – the *Object Game* – worth and value is judged by the participants[19].

Furthermore, *construct validity* "refers to the quality of the conceptualization or operationalization of the relevant concept" (Gibbert et al., 2008; 1466), which can be enhanced through triangulation of data sources and methods (Miles and Huberman, 1994). *External validity* or transferability may be regarded to

[19] *Appendix I* is an 'evaluation' of the Object Game (in Danish).

analytic/theory-connected, case-to-case transfer, and *'theoretical'* validity, the latter is "the presence of a more abstract explanation of described actions and interpreted meanings" (Miles and Huberman, 1994; 279). The bodies of literature on brokers, capabilities, and objects is used in the PhD study as a theoretical lens to understand the roles of these in collaborative innovation projects.

Maxwell (2013) provides two positive examples of using existing theory in qualitative research: *'theory as a coat closet'* and *'theory is a spotlight'* (p. 49). The former, a researcher may 'hang' pieces of data, organize data according to theory, and thereby see the connections in data. The latter is an example of a useful theory that illuminates what the researcher sees, thereby drawing the attention to particular phenomenon, and sheds light on relationships (Maxwell, 2013). Arguably, the empirical research conducted in the PhD study uses existing theory as a 'spotlight', and thus connecting concepts in data in an inductive and abductive style.

Moreover, the findings in the multiple case studies include elements, which may be transferred, replicated and applied in other situations of collaborative boundary practices. Hence, the findings on the roles of brokers, capabilities, and objects in collaborative innovation projects have *external generalizability* (Maxwell, 2013), which is the *external validity* of applying results to new situations, people, or settings (Gibbert et al., 2008; Creswell, 2014). This is similar to *analytical generalization* (Yin, 1994; Gibbert et al., 2008), which "involves a reasoned judgment about the extent to which the findings of one study can be used as a guide to what might occur in another study" (Kvale and Brinkmann, 2009; 262). It is a process that "refers to the generalization from empirical observations to theory" (Gibbert et al, 2008; 1468), and according to Eisenhardt (1989), cross-case analysis with four to ten case studies for theory development may provide a good basis for analytical generalization.

The eight case studies and the co-design workshop using an exploratory design game to gather different type of data than what can be obtained through semi-structured interviews, may provide a good foundation for analytical generalization. The findings from this PhD study can be used as a guide to what may occur in similar settings – collaborative boundary practices with the use of innovation projects as a mechanism.

Table 2.3. Data analysis in multiple case studies

Case	Type of analysis	Type of data
Alpha Bakery (pilot study)	○ Content	▪ Interview ▪ Warm-up questionnaires ▪ Follow-up questionnaire ▪ Document (public reports, websites)
Alpha	○ Content ○ Conversation ○ Interaction	▪ Interview ▪ Audio- and visual ▪ Document (project applications, public reports)
Beta	○ Content ○ Conversation ○ Interaction	▪ Interview ▪ Audio- and visual data ▪ Document (project applications, public reports)
Gamma	○ Content	▪ Interview ▪ Document (project applications, public reports)
Delta	○ Content ○ Within-case (tables) ○ Cross-case (tables)	▪ Interview ▪ Document (project applications, public reports)
Epsilon	○ Content ○ Within-case (tables) ○ Cross-case (tables)	▪ Interview ▪ Document (project applications, public reports)
Zeta	○ Content ○ Within-case (tables) ○ Cross-case (tables)	▪ Interview ▪ Document (project applications, public reports)
Eta	○ Content ○ Within-case (tables) ○ Cross-case (tables)	▪ Interview ▪ Document (project applications, public reports)
Theta	○ Content ○ Within-case (tables) ○ Cross-case (tables)	▪ Interview ▪ Documents (project applications, public reports)

2.4.1. Cases: Delta-Theta

Data analysis for cases – *Delta, Epsilon, Zeta, Eta,* and *Theta* – was conducted in the fall of 2014 and winter 2105, while being a visiting PhD researcher at Centre for Entrepreneurship and Innovation (CEI), Aarhus University (September 2014 to March 2015). This collaboration with the team at CEI resulted in two papers – *chapters 4* and *5* – of this PhD dissertation.

Data for the content analysis was, as *table 2.3* outlines, collected from different individuals through interviews and documents in order to triangulate data for qualitative validity and reliability (Creswell, 2014; Maxwell, 2013). One of the best ways to mitigate impression management and retrospective sense-making is to use "numerous and highly knowledgeable informants who view the focal phenomenon from diverse perspectives" (Eisenhardt and Graebner, 2007; 28). In the five cases, key informants from different boundaries were interviewed, as *table 2.2* shows.

The transcripts from these five cases were prepared for content analysis by the author of this dissertation. After the transcripts had been read, the data from the qualitative interviews was categorized manually in tables (in Excel):

- Who are the primary actors, and who is engaged in the collaboration
- Process of collaboration (description)
- External and internal challenges of the project
- Role and characteristics of SME, Researcher, Broker
- Direct output (i.e., tangible output)
- Indirect output (i.e., output related to the project)
- Understanding of concepts: Innovation, Collaboration
- Motivation
- GTNV-program (positive and negative aspects)
- Duration of the project

Information from documents, such as project applications, were added to the tables. The content for each case with the above categories was re-organized into new tables (in Excel) with more condensed categories into five columns for within-case analysis:

- Interaction enablers
- Collaboration characteristics
- Drivers – with sub-columns of: SME (internal team), Researcher(s), Broker
- Output – sub-columns: direct, indirect
- Challenges – sub-columns: internal, external

Data in the within-case analysis was examined for reoccurring elements to establish themes based on converging several sources of data in cross-case analysis (Miles and Huberman, 1994; Creswell, 2014; Maxwell, 2013). The cross-case analysis resulted in a table with summarized findings of the five collaborative projects (i.e., cases).

Evidence from the five cases was converged to represent the same descriptions of the process; this was done to overcome potential self-report bias, and thereby make validity threats regarding the process elements implausible by evidence (Maxwell, 2013). For further description, please refer to the the section on research methods in *chapter 4*.

2.4.2. Cases: Alpha-Gamma

The three cases of collaborative innovation projects, *Alpha, Beta,* and *Gamma,* were conducted after the data analysis of five cases – *Delta* to *Theta*. The interview guides (*Appendix C*) were inspired by previous interview guides used in cases *Delta* to *Theta*, but with a sharper focus on the process, the role of brokers, and especially objects used. Interviews were carried out primarily with the CEO or top manager of the SME to gain an understanding of the process they have been through as a firm, and to investigate which objects and how these have been used to share knowledge with the external actors (e.g., academic researchers and brokers). Interview data was analyzed and this shed little light on the use of objects in knowledge sharing processes.

To gather more data on this matter through a different method, the *Object Game* was developed as an exploratory research tool and used in a workshop with cases *Alpha* and *Beta*. *Gamma* was also invited to the workshop, but chose not to participate. Moreover, in collaboration with Associate Professor Hanne Lindegaard, co-author of *chapter 6*, the designing process of the *Object Game* and facilitation of workshop resulted in valuable contribution to the PhD project.

From the interviews, quotes were used in the five theme cards of the workshop (*Appendix F*), with participation of key informants from cases *Alpha* and *Beta*. The five themes were *Knowledge-based collaboration, Chemistry, Dialogue & Interaction, Knowledge,* and *Innovation.* The quotes were meant to spark a discussion among the participants in one group setting. This discussion is perceived as a confirmation of the participants' previous descriptions and meanings, and a more in-depth elaboration in a dynamic group setting, where participants were inspired by each other's statements and experiences. Audio recording from this discussion was transcribed and analyzed according to its content on the five themes[20].

Furthermore, interview data from all eight case studies was used to develop a descriptive classification of objects (*chapters 6* and *7*) and is integrated into the *Object Game*. Inspired by theory on knowledge sharing processes, the different types of knowledge flows came about: transfer, exchange, generation, and integration[21].

[20] *Appendix G* includes parts of the participant discussion. A summary with key points is provided in *section 1.5*.
[21] Please refer to *section 3.1.2* in *chapter 3* (literature review).

Audio and visual documentation from the workshop was used for the conversation and interaction analysis[22]. Audio recordings (voice recorder and camera) captured dialogues, and visual recordings (camera) show the interactions with tangible pieces from the *Object Game,* and dialogues between participants as triggered by the game setting. Images (pictures) with results from the game were analyzed for the greater picture on how different objects facilitate knowledge flows as used by the actors in collaborative innovation projects.

2.4.3. Case: Alpha Bakery (pilot study)

The case study on *Alpha Bakery* is a pilot study (*Appendix B*) that guided the subsequent research process in the PhD project. Interview data (i.e., transcripts) in the pilot study was analyzed primarily according the structure and themes of the interview guides (*Appendix D*), which included conceptual, factual and narrative questions. Conceptual questions regarded the interviewees' interpretation of 'open innovation' and 'collaboration'. Factual questions touched upon the process of collaborating with external actors, as well as the process of searching for external knowledge. These collaborations are captured by collaborative projects, and thus a mapping of their projects was conducted in the data analysis. Information and facts on these had not been attained in the interviews, and therefore an extensive 'follow-up' questionnaire was developed (*Appendix D*). The content of the questionnaire was analyzed in relation to the interview data, and this resulted in an extended summary written in Danish.

This extended summary was sent to the interviewees for validation of information and to receive feedback to ensure construct validity (Gibbert et al., 2008) and internal validity (Miles and Huberman, 1994). Different data sources was used, other than the interviews, including annual reports, websites, and news articles, for triangulation purposes and data quality (Miles and Huberman, 1994). The subsequent qualitative data was analyzed according the theoretical framework of dynamic capabilities i.e. search and selection processes (e.g., Helfat et al, 2007; Teece, 2007).

This pilot study included some lessons learned about the empirical setting (of projects with external knowledge actors), which guided the empirical research conducted in the PhD project. One of the lessons learned was that observing dynamic capabilities and the underlying search and selection processes is difficult. However, this pilot study does arrive at some important findings for understanding what characterizes this type of firm, what are the drivers of search and selection processes, and where does the firm source knowledge for its innovation activities.

[22] *Chapter 6* presents the findings from the conversation and interaction analysis, and the role of objects is further discussed in *chapter 7*.

The intent was to investigate the role of brokers in their open innovation processes with external knowledge actors. The manufacturing SME has engaged with several external knowledge actors at various institutions and through different programs. Without a clear understanding of who are the 'brokers' and where are they located, it is troublesome to pinpoint their role. This is another lesson learned from the pilot study: exploring the role of brokers needs to be within a certain structure and this guided the research toward the regional program, which is the central empirical lens in the PhD project.

As a pilot study, the findings highlight some of the key challenges and drivers in search and selection processes that need further investigation, including *short-term collaborative projects*, *external funding opportunities*, *brokerage activities for better collaboration process*, *access to new knowledge*, and *integration of new knowledge*. The GTNV-program addresses these, and therefore the GTNV-program as an empirical lens is a valuable structure to explore the different actors engaging in collaborative innovation projects where the roles of brokers, capabilities and objects are an integral part.

Bridge to *PART II. LITERATURE REVIEW*

Part I with *chapters 1* and *2* introduces the area of research, its objective and aims, scope of the research, and addresses the research approach of the PhD project. It presents the multiple case studies and data selection, collection and analysis, as well as discusses the use of an exploratory design games in the research activities.

The following part of the PhD dissertation is an extended literature review. *Chapter 3* addresses the body of literatures within innovation management, knowledge management, and strategic management, including various concepts of knowledge brokers, brokering activities, innovation processes, dynamic capabilities, boundary objects, and design games. Without an understanding of theories and concepts within these fields, the research has little meaning.

The various strands of research are connected and can be explored through the empirical lens – GTNV-program. As discussed and illustrated in *chapter 3*, this combination of an empirical setting and theoretical understanding shapes new 'collaborative boundary practices' via the empirical research conducted in *Part III*.

PART II.

LITERATURE REVIEW

Chapter 3. Theoretical lens

The empirical setting researched in this PhD project is the Danish regional program, GTNV-program, which functions as an overall mechanism to create interactions between SMEs and Academia for collaborative innovation. The underlying mechanism is collaborative innovation projects. Projects in the context researched are coordinated and facilitated by an operator and independent third parties.

In order to explain how SMEs collaborate with Academia through collaborative innovation projects facilitated by the GTNV-program, we need to tap into various bodies of literature within innovation management, knowledge management, strategic management, and concepts such as dynamic capabilities, knowledge brokers, boundary objects, and design games. These fields and concepts will help us understand what goes on when SMEs collaborate with Academia, and therethrough find the answers to 'how', as well as 'why' it is positive for SMEs to engage in collaborative innovation projects with academic researchers through processes that are facilitated by brokers and the use of objects to integrate knowledge from outside the firm.

Innovation and the ability to change in order to survive is the reality of many small and medium-sized enterprises (SMEs). SMEs can change, learn to change, and transform themselved by interacting with other types of knowledge bases, such as the academic knowledge base. But how to do that, we look at the innovation processes between the two and investigate how this affects the firms ability to develop dynamic capabilities and thereby the ability to change and transform.

There are different actors involved in these processes – and each plays a different role. Their actions and set of activities in this context form *collaborative boundary practice* leading to change and innovation in firms. This literature review explores the theories and studies within the fields of innovation management, knowledge management, dynamic capabilities, knowledge brokers and brokering, objects and design games. It is the theoretical foundation for the empirical research, which focuses on the elements of object, brokers and capabilities in the process of collaborative innovation.

All these elements are present in the GTNV-model briefly presented in the introduction-part. The GTNV-model is further developed in the empirical research by drawing parallels between the dynamic capacilities framework (Teece, 2007), generic routines for knowledge management in innovation projects (Tranfield et al., 2006), and knowledge sharing (Nonaka, 1994). The GTNV-model is therefore developed into a *process model of dynamic capabilities for knowledge sharing in collaborative innovation projects*.

The PhD dissertation shapes and defines *collaborative boundary practices* through the GTNV-model. This is a special opportunity to empirically explore and

theoretically investigate the interconnectedness between the fields of innovation management, knowledge management and dynamic capabilities within a framework applied empirically. A special attention is also given to the roles of the brokers and objects in collaborative innovation projects.

The literature review dives into a large conceptual knowledge base, presenting the different theories and concepts, and discuss how the interconnectedness between the variety of concepts in order to provide the theoretical lens for a useful explanation of *how SMEs collaborative with Academia.*

The theoretical lens is built by starting with *Innovation and knowledge* (*section 3.1*) with innovation as output, process and capability, and knowledge as an important resource for innovation. *Section 3.2* on *Collaboration, external knowledge, and absortive capacity* discusses the concepts within the realm of university-industry collaboration and facilitating knowledge flow through different models, including the GTNV-model (e.g., empirical lens) and comparing it to other models. Researchers in the field of university-industry collaboration study different aspects; many focus on the barriers and some study the more positive aspects of collaboration. This PhD study follows the lines of exploring the drivers of SMEs' collaboration with Academia, and thus focusing on the positive aspects by studying 'successful' collaborative projects.

Section 3.3 digs into the vast literature on dynamic capabilities to uncover what are resources, capabilities, and microfoundations – and why these are important for an SME's survival or growth. Dynamic capabilities are about 'change' and therefore closely related to 'innovation;' however, they are not the same. Learning, best practices, and how dynamic capabilities are developed and deployed, is also addressed in this section.

Collaborations where brokers are involved, inevitably brokers have a role in those interactions. *Section 3.4* on *Knowledge brokers and brokering in innovation processes* addresses the roles of brokers identified in other studies. It is important to understand this in order to explore what the role of brokers are in the GTNV-program (empirical lens) and how they potentially play a role in building capabilities in SMEs.

In the collaborative innovation projects, the actors communicate in their processes, not only verbally but also with the assistance of objects or through objects. To explore at micro-level how knowledge flows between two or more actors, objects carrying information and knowledge are studied empirically, and therefore the body of literature on objects and boundary objects is addressed in *section 3.5*. In this section, research on types of objects and transformation of knowledge through objects is discussed, as well as research on design games and how these facilitate a different type of dialogue between actors from different boundaries.

Section 3.6 is the positioning of the PhD project, which aligns the empirical lens with the theoretical lens. The research questions, as formed by the literature review and empirical curiosity, concludes *chapter 3* with the theoretical lens for the PhD study.

3.1. Innovation and knowledge

Innovation is one of the main driving forces of economic growth (Salter and Alexy, 2014) in today's *innovation economy*, which is characterized by uncertainty and constant change, where the key to success is learning quickly and effectively (Boer and Bessant, 2004; Govindarajan and Trimble, 2004). Knowledge is the most fundamental resource in the modern economy, and learning is the most important process (Lundvall, 2010). In the context of national systems of innovation, the processes of interactive learning are perhaps the most important forms of learning, which are socially embedded (Lundvall, 2010). But what is innovation? The term comes from Latin ('innovare') and in its broadest sense means 'to make something new'; it is "a process of turning opportunity into new ideas and of putting these into widely used practice" (Tidd and Bessant, 2013; 19).

Innovation is about knowledge and creating new possibilities through combining different knowledge bases, and managing innovation is about turning uncertainties into knowledge, which can only be done by committing resources to reduce the uncertainty – this is essentially a balancing act (Tidd and Bessant, 2013). One of the main challenges when dealing with uncertainty lies in the nature of human beings, as people prefer, seek out, and expect certainty (Davenport et al., 2006). Managers face significant challenges to unlearn passed successes, and what caused them, since these tend to lead to path dependency (Davenport et al., 2006). Learning must come through trial and error, as strategic innovation involves exploring the unknown to create new knowledge and new possibilities (Govindarajan and Trimble, 2004). However, as Baden-Fuller (2006) argues, "The problem faced by many mature organizations is that renewal and change appear very risky, much more risky than the status quo. This perception has to be changed" (p.411). Firms need to adopt a collaborative value-innovation mindset and strategy mindset that include new perceptions of invisible resources, learning and knowledge as competencies, as well as creative and emergent dynamics for the mental space of 'capability space' (Davenport et al. 2006; 123). As Louis Pasteur once said, "Chance favors the prepared mind."

3.1.1. Innovation – output, process, capability

In the literature, innovation is an output, a process, and a capability (Conway and Steward, 2009). As a process, innovation is the invention, development, and implementation of new ideas (Garud et al., 2013). The model of innovation as a process turns ideas into reality to capture value (Tidd and Bessant, 2013); a process characterized by uncertainty, complexity, diversity, and interdependence (Clausen and Kerndrup, 2014; Boer, 2015). A simplified model of innovation management includes the phases of search (or generate), select, implement, and finally capture (Bessant and Tidd, 2007; Tidd and Bessant, 2013); when depicted, it is a rather linear process, but reality is more complex and iterative. Innovation is a multiplayer game,

as innovation processes can be regarded as complex and dynamic, and thus a result of cumulative interaction and learning processes involving many different actors," as stated by Bessant and Tidd (2007). Managing this process essentially requires 'innovation capability', which refers to the firm's ability to create and operate in the realm of innovations (Tidd and Bessant, 2013).

There are several innovation models and concepts: S-curve model of innovation diffusion (Rogers, 1962), user-driven innovation (von Hippel, 1986), stage-gate model for product development (Cooper, 1990), disruptive innovation (Christensen, 1997, 2003), business model innovation (Amit and Zott, 2001; Osterwalder and Pigneur, 2010), Open Innovation and open business models (Chesbrough, 2003; Christensen and Raynor, 2003), to name a few. Critique came from Van de Ven (1986), among others, on the normative and structured innovation models, as those do not capture the complexities and dynamics of innovation; they do not reflect reality. Van de Ven et al. (1999) describe the innovation journey in larger firms through an empirical research following the process of innovation in longitudinal case studies. Imai (1986) depicts innovation over time as periods with continuous improvement to practice, followed by a breakthrough with radical innovation, which then is followed by a period of continuous improvement ('Kaizen'), and so forth. Nonetheless, the key is resourcing, organizing and managing innovation (Boer, 2015).

Innovation involves the commercialization of technological change (Rothwell and Zegveld, 1985; Conway and Steward, 2009). Schumpeter's concept of creative destruction is grounded in the innovation literature, and the notion of an innovation is new combinations of existing knowledge that is combined in new ways (e.g., Lundvall, 2010). Hargadon (2003) calls this *recombinant innovation*, where old ideas are converted into new ideas in new contexts. Nonetheless, the innovation literature assumes that innovation is always good – a process of creative destruction. However, innovation may benefit the few at the expense of the many, which is a process of destructive creation (Soete, 2013).

There are four dimensions of the innovation space – the *4Ps of innovation space* (Francis and Bessant, 2005; Tidd and Bessant, 2013). It includes Product innovation (i.e., introduce or improve products), Process innovation (i.e., introduce or improve processes), Position innovation (i.e., define or re-define the positioning of the firm or products), and Paradigm innovation (i.e., to define or re-define the dominant paradigm of the firm). Each of the four Ps runs on a continuum from incremental innovation ('do what we do better') to radical innovation ('do something different'). Henderson and Clark (1990) developed a typology of innovation based on the reconfiguration of existing technologies by providing a more nuanced understanding of innovations, other than incremental innovation and radical innovation. The authors distinguish between the components and architecture of a product, and include 'architectural innovation' and 'modular innovation' to their typology (Henderson and Clark, 1990).

As Rush et al. (2007) point out, “The term innovation covers an extremely broad range of activities including, among other things, organisational, financial, marketing and technological innovation” (p. 222). A broad definition of innovation is provided in the Oslo Manual, “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 in business practices, workplace organisation or external relations” (OECD, 2005; 46). There are different types of innovation outputs, including product innovation, service innovation, process innovation, marketing innovation, and organizational innovation (e.g., OECD, 2005). According to the definition by OECD (2005), “An organisational innovation is the implementation of a new organisational method in the firm’s business practices, workplace organisation or external relations” (p. 51).

A broad and short definition of innovation, with merely five words, is “something different that has impact” (Anthony, 2012; 15), where *different* is defined in the eye of the beholder, and *impact* means some kind of measurable result, for instance improved performance of a process, or profit. Anthony (2012) claims that innovation is a process of discovering an opportunity, creating an idea to seize the opportunity, and then implement the idea to achieve results; thus, if there is no impact, there is no innovation.

Firms implementing a new method of external collaboration are essentially, in a broader sense, engaging in organizational development and organizational change, and in a more narrow sense, organizational innovation. This new organizational method can have implications for innovations, such as developing new products with external sources (i.e., product innovation). It is an organizational change that may lead to organizational learning through specific mechanisms, one of which are collaborative innovation projects. In fact, projects serve as forums for pursuing new opportunities (Garud et al., 2013) and are formal mechanisms for knowledge integration practices (e.g., Bengtsson et al., 2015). To distinguish between the terms *innovation* and *change*, there is a degree of novelty to innovation; innovation requires change, but not all changes lead to innovation (Conway and Steward, 2009).

Innovation is inherently a process that historically has been studied and described in various ways. Rothwell (1994) outlines four generations of innovation processes dominating the research: the linear models of technology push (first generation) and market pull (second generation), the coupling model of innovation (third generation), and the integrated innovation process (fourth generation). Rothwell proposes a fifth generation model of innovation, as a process of know-how accumulation with a combination of internal and external/joint learning (1994).

Innovation as an iterative process, where re-innovation – as in improvement or adaptations – to the original innovation signals that innovation is a process and rarely a single event (Rothwell and Gardiner, 1983; Lundvall, 2010). The perspectives on innovation studied in the literature includes the individualist perceptive (i.e., actions of individuals are major source of innovation within the organization), the

structuralist perceptive (i.e., assumes innovation is determined by organizational characteristics, including size, centralization, and formalization), and the interactive process perspective (e.g., a multiple levels of analysis) (Conway and Steward, 2009). The former two cannot account for the complexity of the innovation process, and thus the latter attempts to account for both individual and structural factors through an analysis of their interconnection (Slappendel, 1996). Hargadon (2014) argues that the innovation process reflects the interactions between the three levels of institutional structure, the organization, and the individuals or small group.

In essence, managing (open) innovation is about managing knowledge *flows* across various boundaries (Tidd and Bessant, 2013). Bengtsson et al. (2015) studied knowledge integration across three different types of boundaries: organizational, geographical, and knowledge, where the latter links to the specific knowledge assets of a partner, i.e. knowledge base of a firm. The authors pinpoint the assumption of effective management practices may be the key to integration of knowledge across boundaries (Bengtsson et al., 2015), including the management of how internal and external knowledge is combined (e.g., Foss et al., 2011). A boundary can be described as a sociocultural difference leading to discontinuity in action and interaction (Akkerman and Bakker, 2011a) – a space with the opportunity to learn. Learning at boundaries, including organizational learning, arguably requires knowledge sharing between the various actors from difference boundaries.

The knowledge creation process is closely linked to learning – and organizational learning – a process that increases the knowledge of the firm, which has been created by its individuals and is transformed into the knowledge system of the organization (Garcia-Morales et al. 2007). Garcia-Morales et al. (2007) describe the context of where this process occurs as a "community of interaction" where knowledge is created and expanded in a "constant dynamic between the tacit and the explicit" (p. 528), and they argue that organizational learning and absorptive capacity are complementary dimensions. *Absorptive capacity* is defined as the firm's "ability to recognize the value of new information, assimilate it, and apply it to commercial ends is critical to its innovation capabilities" (Cohen and Levinthal, 1990; 128). Furthermore, organizational performance is linked to the results of yesterday's learning, and the organizational performance of tomorrow will be the product of today's learning (Garcia-Morales et al., 2007).

3.1.2. Knowledge as an important resource

The processes of knowledge sharing and knowledge creation are key elements of the innovation process (Conway and Steward, 2009). Davenport et al. (2006) state, "Knowledge management distinguishes between building the organization's stock of knowledge ('exploration') and deploying the existing stock of knowledge ('exploration'). Separate (or parallel) structures for pursuing both exploratory

activities, e.g. experimenting with new business models, and exploiting activities and optimizing existing value chain configurations, are necessary" (p. 375).

What is 'knowledge'? There is no universally accepted typology on knowledge. However, knowledge can be distinguished from data and information (Bessant and Tidd, 2007). Data are raw numbers, observations, words, etc. that are easy to structure and store. Information is data that are organized, grouped and categorized in patterns. Knowledge is information that has been analyzed in a broader context and thus contextualized and gives meaning (Bessant and Tidd, 2007; Conway and Steward, 2009). Knowledge is information that is "relevant, actionable, and at least partially based on experience. It implies an understanding of processes, situations and interactions, and includes both skills and values. Knowledge may derive from science, history, structured education and vicarious as well as personal experience" (Leonard, 2011; xiv). Knowledge is therefore deeper and richer than information.

Knowledge types can be classified as *explicit* and *implicit* (Nonaka, 1994; Nonaka and Takeuchi, 1995), *tacit* and *codified* (Polanyi, 1958). Tacit knowledge is "deeply rooted in action, commitment, and involvement in a specific context" (Nonaka, 1994; 16). Tacit knowledge may be defined as 'heuristic, subjective, and internalized knowledge', and needs to be learned through experience and practice (Conway and Steward, 2009). In contrast, codified knowledge can be articulated and transferred through formal and systematic language in, for instance, through textbooks and manuals (Conway and Steward, 2009). Explicit knowledge can be codified, stored, and more easily communicated, whereas implicit knowledge or tacit knowledge is personal, context-specific, experiential, and hard to communicate (Bessant and Tidd, 2007). Non-codifiable knowledge refers to knowledge that does not have the potential of being codified (Orr, 1990). Knowledge that is 'sticky' is context-specific and does not travel from for instance one project to another (von Hippel, 1994). *Knowing how* refers to tacit knowledge, and *knowing about* refers to explicit knowledge (Grant, 1996b). Nonaka (1994) and Grant (1996a) both cite Polanyi (1966), 'we can know more than we can tell'.

In the knowledge management literature, knowledge is generally assumed to be either located in physical or virtual form, or within the heads of individuals; at an abstract level, knowledge may be seen as embedded in organizational processes or embodied within artefacts, as technology (Conway and Steward, 2009). Nonaka (1994) presents four modes of knowledge conversion, assuming that knowledge is created through the conversion between tacit and explicit knowledge: *socialization* (from tacit to tacit knowledge), *externalization* (from tacit to explicit), *combination* (from explicit to explicit knowledge), and *internalization* (from explicit to tacit knowledge). This is also known as the SECI model by Nonaka and Takeuchi (1995). In the process of sharing knowledge, through for instance socialization (Nonaka, 1994), knowledge is acquired by the interacting individuals (e.g, Argote, 1999). Knowledge acquired through interaction can also lead to the generation of *emergent* knowledge, which refers to the knowledge that emerges through discussions among

actors (Argote, 1999). Argote states, “The development of emergent knowledge is particularly important for groups engaged in tasks that involve creativity and innovation” (1999; 114).

According to Carlile (2002), there are three characteristics of knowledge in practice: knowledge is *localized, embedded,* and *invested* in practice. Localized as in knowledge is around particular set of problems in a given practice, embedded in methods, technologies, and knowledge that are hard to articulate, and is invested in “the methods, ways of doing things, and successes that demonstrate the value of the knowledge developed” (Carlile, 2002; 446). Carlile (2002) argues that these characteristics make it hard to work across practices or knowledge boundaries.

Moreover, geographic proximity facilitates intraorganizational knowledge transfer, as well as being embedded in subordinate relationships, such as network, franchise, or chain relationships, facilitates the transfer of knowledge, as discussed by Argote (1999), since these organizations trust each other to a greater extent (Granovetter, 1985). Trust has been defined as “reciprocal faith in others’ intentions and behavior” (Buelens et al. 2006) and “involves a cognitive ‘leap’ beyond the expectations that reason and experience alone would warrant” (p.382).

Trust is a key feature in relationships (Conway and Steward, 2009). Trust between organizations can be categorized as *contractual trust* (i.e., the expectation that a trading partner will adhere to agreements and promises), *competence trust* (i.e., the expectation that a partner will perform its role completely), and *goodwill trust* (i.e., the mutual expectation of open commitment between trading partners) (Sako, 1991). High interorganizational trust is necessary for the generation of learning and innovation, as high levels of trust facilitate the communication of tacit knowledge that is proprietary and commercially sensitive (Dodgson, 1993). According to a study by Davenport et al. (1999), cultural differences have some positive impacts of the development of competence trust, whereas goodwill trust emerges only through repeat collaborative relationships.

Futhermore, the knowledge-based theory of the firm recognizes the firm as an organization that integrates knowledge (Grant, 1996b). *Knowledge integration* includes knowledge combination (Kogut and Zander, 1992), and thus the combination of knowledge bases in order to develop new or existing products, processes, and services. The knowledge base of a firm is ‘what the firm knows’ (Zahra et al., 2006). In the knowledge-based theory of the firm, Grant (1996a) claims that “knowledge is the preeminent resource of the firm,” and “organizational capability involves integration of multiple knowledge bases” (p. 384). Knowledge as a resource are intellectual assets, which are rather invisible assets (Davenport et al., 2006) perceived as central to sustaining firm competitiveness (Teece, 2007).

Tranfield et al. (2006) developed a hierarchical process model of knowledge management for innovation; building knowledge management capabilities for innovation projects are generic routines as sub-sets for the phases in the innovation

process, i.e. *discovery, realization,* and *nurture*. The *discovery* phase in the innovation process included the generic routines of search, capture, and articulate; *realization* includes contextualization and application; whereas, *nurture* includes the generic routines of evaluate, support, and re-innovate (Tranfield et al., 2006).

The primary role of the firm is to integrate individuals' specialist knowledge, through for instance the mechanism of organizational routines, for which the essence is that "individuals develop sequential patterns of interaction which permit the integration of their specialized knowledge without the need for communicating that knowledge" (Grant, 1996a; 379). Grant (1996b) argues that transferring knowledge is an inefficient approach to integrating knowledge; establishing modes of interaction in which the knowledge of the specialists is integrated is the key to efficiently achieving effective integration of knowledge.

Knowledge creation can be the main focus in collaborations between multidisciplinary fields, which can be bridged through projects. Fong (2003) proposes five processes for knowledge creation in multidisciplinary project teams, which starts with a pre-requisite boundary-crossing process, then three knowledge processes of knowledge sharing, knowledge generation, and knowledge integration – with collective (project) learning as an integral part of the three knowledge processes. In an organizational context, one may argue that knowledge is an input to achieve organizational goals (Bessant and Tidd, 2007). Knowledge integration is arguably essential for the absorption of knowledge created to be completed. This is where new context- and situation-specific knowledge generated in the boundary-crossing activities are absorbed, integrated, and applied for instance operational activities – knowledge as an input for organizational goals.

The concepts of 'knowledge *something*,' e.g. knowledge "sharing" has been used in many contexts by many researchers in the field of knowledge management. Nevertheless, what do the words actually mean? Browsing through online dictionaries, the word "sharing" means "to divide and distribute in shares; apportion" (Dictionary.com), "to divide and distribute in portions" (Merriam-Webster.com). Furthermore, the words "transfer," "exchange," "generation" (other word for creation), and "integration" and their meaning become more clear after searching for their definitions in dictionaries.

The word *transfer* means, "to convey or remove from one place, person, etc., to another" (Dictionary.com), "to convey from one person, place, or situation to another" (Merriam-Webster.com). *Exchange* means, "to give and receive reciprocally; interchange" (Dictionary.com), "the act of giving or taking one thing in return for another," and *trade* is the synonym for exchange (Merriam-Webster.com). *Generate* means to "bring into existence; cause to be; produce" (Dictionary.com), "to bring into existence" with the synonym *produce* (Merriam-Webster.com). Finally, *integrate* means "to bring together or incorporate (parts) into a whole" (Dictionary.com), "to form, coordinate, or blend into a functioning or unified whole," and to *unite* (Merriam-Webster.com).

Contextualizing these words and concepts to the context of collaborative innovation between SMEs and academia, the following 'definitions' are developed for the purposes in this dissertation:

- *Knowledge transfer* is a one-way knowledge flow from one knowledge base to another. This is typically a flow of knowledge from academia to business.
- *Knowledge exchange* is (at least) a two-way knowledge flow, an interchange, between two (or more) knowledge bases. Generally, knowledge is not created through an exchange.
- *Knowledge generation* is the act of bringing into existence, the creation of, new context- and situation-specific knowledge. It is the transformation of existing knowledge.
- *Knowledge integration* is the unification of, the act of absorbing, newly generated context- and situation-specific knowledge into existing or new operational tasks, processes, products, or services.

These 'definitions' are the four types of knowledge *flows* can be interpreted as a sequential and yet as parallel and iterative flows in knowledge sharing processes. These four types of knowledge flows are incorporated into the empirical research, and in testing the roles of objects in collaborative innovation projects through the design game and boundary object, the *Object Game*[23].

Knowledge flows between different actors in collaborative innovation projects. These projects are by nature collaborations where the firms are in contact with external knowledge, and the next section addresses concepts of absorptive capacity, Open Innovation, university-industry collaboration and models through which firms and academia can interact.

[23] *Chapters 6* and *7.*

3.2. Collaboration, external knowledge, and absorptive capacity

A critical form of innovation is integration, from an ecosystem perspective, as firms can use resources that exist outside its own organization (Iansiti and Levien, 2004). For analytical purposes, the environmental context is the *business ecosystems*, which includes institutions, organizations, customers, and suppliers (Teece, 2007). Successful companies transform information into value-creating knowledge by seizing knowledge asymmetries in the innovation economy, and one of the drivers in the innovation economy is "new sources of value" (Davenport et al., 2006; 17). Arguably, firms that include knowledge institutions in their business ecosystem have the potential to reap the benefits of asymmetric knowledge and thereby co-shape knowledge for value innovation.

Davenport et al. (2006) state that business ecosystems and *co-shaping of value innovation* form new business models. The managerial capabilities in today's economy includes managing new collaboration activities (Baden-Fuller, 2006). The requirements of management include a co-creating mentality and broad innovation, where the focus of innovation is not limited to products and the R&D department, but is a holistic approach to innovation across departments and organizations (Davenport et al., 2006). These are *proactive, collaborative,* and *systemic approaches* in strategic management that focus on the holistic construction of value (Davenport et al., 2006). In relation to strategy, collaboration with external actors for knowledge acquisition can be perceived as a tactic. This means that sourcing external knowledge is a strategic choice, whereas the action of collaborating with different external actors is a tactical maneuver (Davenport et al., 2006) to achieve a specific goal. From this perspective, strategy is the *what* (sourcing external knowledge) and tactic is the *how* (process of collaboration).

Collaboration is part of innovation management, as innovation processes in organizations include some form of collaboration, which is defined as "the shared commitment of resources to the mutually agreed aims of a number of partners" (Dodgson, 2014; 462).

The act of collaborating with external partners is to explore a different type of knowledge than the one the firm has in its resource base, and it is arguably a mechanism supporting improvement innovation, e.g. 'do what we do better' and continuous innovation (Boer and Bessant, 2004). Learning (and continuous learning) is the key process for continuous innovation, and learning may occur when recombining existing knowledge (Hargadon, 200; Boer, 2004; Boer and Bessant, 2004). Firms opening up and collaborating with external partners in innovation processes is by many referred to as *Open Innovation*; the term 'Open innovation' was coined by Chesbrough (2003) and is defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, 2006; 1).

This Open Innovation paradigm assumes that firms use both internal and external ideas when innovating, and Chesbrough (2004) uses the metaphor of *Poker* for Open Innovation and *Chess* for Closed Innovation. Recently, Chesbrough and Bogers (2014) proposed an Open Innovation definition of "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model." The opposite side of the open innovation spectrum is closed innovation, which essentially is the use of internal resources only. In reality, firms' practices lie somewhere between being completely open or completely closed. Spithoven et al. (2012) recognizes the concept of open innovation as offering an analytical framework to explain the process of innovation, as well as promoting a management toolbox containing practical guidelines on the organization of innovation.

Furthermore, there are three Open Innovation process archetypes (Gassmann and Enkel, 2004): *inside-out process, outside-in process,* and *coupled process*. Enhancing the firm's knowledge base through the integration of external knowledge sourcing, including suppliers, customers, and institutions, is an outside-in process (Enkel et al., 2009), which has the potential to increase the firm's innovativeness (Laursen and Salter, 2006). According to Enkel et al. (2009), the coupled process refers to co-creation with complementary actors through collaborations, joint ventures, and alliances, where the firm combines the outside-in process with the inside-out process by essentially gaining external knowledge and bringing ideas to the market, and thereby developing and commercializing innovation.

Lichtenthaler (2011) develops a conceptual framework for Open Innovation based on the three critical processes of knowledge exploration, knowledge retention, and knowledge exploitation – all organized internally and externally – at the level of the organization, project, and individual. Dahlander and Gann (2010) discuss the different types of open innovation as 'inbound innovation' and 'outbound innovation', whereas Felin and Zenger (2014) compare the different forms of open and closed innovations according to their governance forms. Partnerships and alliances have bilateral and socially embedded communication channels, cooperative and high-powered incentives, and negotiated property rights (Felin and Zenger, 2014).

Moreover, university-industry partnerships is one of many forms of collaboration (Dodgson, 2014), which can be very difficult for firms to manage, primarily because of the difference in time horizons (Pavitt, 2005). These are *horizontal* relationships where actors gain access to complementary knowledge, in contrast to *vertical* relationships such as collaborations with suppliers and customers (Håkansson, 1990; Tidd et al., 1997). How firms and universities interact varies considerably; for large corporations, complementary processes of interaction take the form of direct industrial funding of university research, research personnel exchange, and university-based consultants (Pavitt, 2005). Technology transfer are to some extent

based on a linear, 'technology push' model of innovation, where universities perform research that generate innovations for industry (Rothwell, 1994; Pavitt, 2005).

3.2.1. University-industry collaboration and facilitating knowledge flow

Perkmann and Walsh (2007) focus their research on university-industry *relationships* rather than *links*, from an open innovation perspective, on a wide range of channels. These channels – or interaction mechanisms – vary considerably across industries, as well as how they are deployed (Perkmann and Walsh, 2007). Relationship-based mechanisms exceed the university-industry links of technology or knowledge transfer (i.e., patents and IP), according to Perkmann and Walsh (2007), and university-generated knowledge is relevant for the latter stages of the innovation processes, not only for novel or radical innovations.

The authors argue that consultancy activities are relevant for SMEs; the majority of SMEs do not pursue formal R&D activities, and thus this provides the rationale for government-sponsored initiatives (Perkmann and Walsh, 2007). They also distinguish between two types of university-industry relationships: *research partnership* and *research services*. The former includes collaborative research activities that generate output of high academic relevance with potential to be used for academic publications. Research partnerships can range from small-scale and temporary projects to large-scale and permanent organizations. Research services is consultancy and contract research provided by the academic researcher, based on the demands of industry, and thus the output is less useful for academic publications. These are collaborative research arrangements that often are subsidized by public policy programs (Perkmann and Walsh, 2007).

Policy programs and innovation policies play a role in developing ecosystem with various actors. One type of ecosystem is the constellation of university-industry-government relations (Etzkowitz and Leydesdorff, 2000); a *Triple Helix model* that "attempts to account for account for a new configuration of institutional forces emerging within innovation systems" (Etzkowitz et al., 2000; 314). According to Etzkowitz and Leydesdorff (2000), "the Triple Helix thesis states that the university can play an enhanced role in innovation in increasingly knowledge-based societies" (p.109). An 'entrepreneurial university' has a *third mission*, other than teaching and research, which is that of economic development (Etzkowitz and Leydesdorff, 2000). With the emergence of knowledge-based innovation, the role of the entrepreneurial is to improve regional and national economic performance (Etzkowitz and Leydesdorff, 2000; Etzkowitz and Klofsten, 2005). Etzkowitz and Klofsten (2005) develop a model of knowledge-based regional development with four stages of *inception, implementation, consolidation,* and *renewal*.

In the literature, the role of the university in the innovation processes can be placed on a wide spectrum: as a source of technical information and expertise; as innovator and a source of technology; as co-developer; and as entrepreneur (Conway and

Steward, 2009). Firms benefit from collaborating with knowledge institutions, including universities or other research institutes (Turpin et al., 1996; Etzkowitz and Leydesdorff, 2000), as these generate sales of innovative products and services novel to the market, and thereby improving growth performance of firms (Belderbos et al., 2004). Furthermore, Curran and Blackburn (1994) recognize that SMEs are important actors in creating, applying and introducing innovations in local economies. Although there are great innovative potential in industry-university collaboration, the firms and universities "generally operate under very different cultures, manifested in divergent goals, conflicting time orientations, and differences in language and underlying assumptions", and there remains cultural predispositions in the two worlds against interacting with each other (Conway and Steward, 2009; 385).

Futhermore, Perkmann and Salter (2012) develop four models of industry-university collaboration, each with its benefits and drawbacks: *Idea Lab* (open, short-term), *Grand Challenge* (open, long-term), *Extended Workbench* (protected, short-term), and *Deep Exploration* (protected, long-term). Working with universities poses challenges for managers, including the degree of openness and time horizons; however, universities can be turned into valuable partners, in the short- and long-run (Perkmann and Salter, 2012).

The type of collaboration in the GTNV-model (*figure 1.5* in *chapter 1*) is similar to Perkmann and Salter's *extended workbench*, which is one of the four models of university-industry collaboration combining two dimensions – time horizon and degree of disclosure (2012). The *extended workbench* is a *short-term* and *protected model* for collaboration with a high chance of implementing the academic's work and knowledge into commercialization. This model for collaboration closely matches academic knowledge bases to firms' problems.

The GTNV-model provides similar benefits as the *extended workbench*. Building relationships with key university partners and operators for continuous collaboration is important for this type of interaction (Perkmann and Salter, 2012). Nonetheless, the importance of dividing the collaboration process into three phases (*figure 1.6* in *chapter 1*) gives the firm the opportunity to test if a collaboration with an academic researcher is the appropriate solution or recognize whether a different type of collaboration (in the innovation system) better fits their needs and expectations.

There are elements from the Stage-gate process in the GNTV-model. The stage-gate process (Cooper, 1990) is a conceptual and operational map for projects, where an idea is turned in to something tangible or applicable, which then is either launched or implemented. The process has *stages* and *gates*. At the *stages,* actors perform activities (in the GTNV-model, these are called *phases*). Each stage is followed by a gate, and at the *gates,* decisions on keep going or termination are made. The specific process in the GTNV-program is illustrated and explained in the introduction-part (*chapter 1, section 1.4*).

The GTNV-model investigated in the PhD study is a platform for making knowledge flow between the firm and academic researcher. One way to make this happen is through facilitation. Minahan et al. (2009) identifies seven phases of facilitation: *enter, contact, discover, decide, implement, evaluate,* and *re-contact*. The first six phases are part of the GTNV-model (as illustrated in *figure 1.6* in *chapter 1*). *Re-contact* may be interpreted as SME and academic researcher continues their collaboration through for instance another innovation project, after the project through the GTNV-program has finished. Does this occur, then it is an indication of relationship-building between the two actors.

This circular process would support relationship building, as building relationships are dynamic by nature (Bessant and Tidd, 2007; Davenport et al., 1999). Combining it with the parallel process of learning, as indicated by Kolb's learning cycle (1984) with the phases of *concrete experience, reflective observation, abstract conceptualization,* and *active experimentation*, it is a continuous process, which occurs along the a relatively linear *timeline* of the phases in the GNTV-model. If firms engage in 're-occurring' collaborations with academic researchers, it would make it a continuous cycle of learning between different knowledge bases, as well as develop their relationship-building capacity.

Futhermore, Pertuzé et al. (2010) identify seven best practices for industry-university collaboration that can bridge the 'outcome-impact gap'. *Outcomes* is a result that creates an opportunity for the firm, including new ideas, solutions to problems produced in the projects, whereas *impacts* is the knowledge generated in the collaboration that can contribute to the firm's products, processes or people. According to their study, only 20 percent of the projects led to major impacts on the firm (Pertuzé et al., 2010).

Zucker et al. (2002) state that when knowledge has an important or large tacit component, the importance of ties suggest interactions and working jointly as a crucial transfer mechanism. The process of *knowledge migration*, which is the movement of knowledge between the industry and university, is subject to redefinition every time it migrates (Iles and Yolles, 2002). Nonetheless, innovation is an interactive process characterized by *uncertainty* and *growing complexity*, and therefore the actors "involved in the creation and adaption of innovations cannot reasonably be assumed to know all the possible outcomes of their activities" (2010; 48).

When collaborating with external actors, an important factor for the firm's ability to acquire new knowledge and diffuse it internally, it its absorptive capacity (Cohen and Levinthal, 1990). Absorptive capacity is a capability and a function of the firm's level of prior related knowledge (Cohen and Levinthal, 1990). Clausen (2013) argues that the investment in absorptive capacity – or capacity-building – is the first step to enter innovation cooperation with external actors, in order to use the *knowledge as inputs* into the innovation process. Investigating the relationship between absorptive capacity and the firm's ability to enter innovation cooperation with external partners

including universities, Clausen (2013) found that the significant and positive driving forces are the educational qualifications of firm's workforce and investments in R&D and training of employees.

External knowledge does not enter freely and therefore the firm and its managers must invest in those aspects of absorptive capacity, which costs have been found to be considerable (Clausen, 2013). This could help explain "why not all organizations are able to assimilate and exploit external information and knowledge in the innovation process" (Clausen, 2013; 68) in an open innovation context. In fact, *access* to external information and knowledge is recognized as an important *driving force* behind success in innovation (Laursen and Salter, 2006). Thus, standing at the interface with the external environment, the combination of access and ability to understand the information is essential. The firm's absorptive capacity depends on the capacity of the individuals standing at the firm's boundary with the external knowledge source or with the firm's internal departments (Cohen and Levinthal, 1990).

The individuals at the border of the firm or organization interacting with the external environment are the 'gatekeepers', or 'boundary spanners', and their role is to diffuse the knowledge from the external source into the firm (Allen, 1977; Tushman, 1977). The absorptive capacity of the firm – its ability to use the new knowledge is key to organizational learning – does not constitute the cumulative capabilities of the gatekeepers but the firm as a whole (Cohen and Levinthal, 1990). As absorptive capacity is *intangible* and its benefits are indirect, as concluded by Cohen and Levinthal (1990), it is rather difficult to state and define the outcome and relationship between investing in building capacity and realizing the returns on investments.

Furthermore, learning processes are sub-elements in the conglomerate of factors and aspects constituting absorptive capacity. An illustrative analogy by Parrilli et al. (2010) associate the generation (or creation) of innovation to the 'processes of learning' which represent the "software of innovation" in the innovation structures, i.e. the "hardware of innovation" (p. 352). The authors suggest that in the context of, and in order to, overcome the *innovation gap* between firms and knowledge institutions, "the importance of processes of codified knowledge flows need to be complemented by interactive flows of tacit knowledge" (Parrilli et al. 2010). There are two modes of learning, according to Jensen et al. (2007), and these are referred to as the Science, Technology and Innovation (STI) mode and Doing, Using and Interacting (DUI) mode. The STI-mode is based on the production and use of codified scientific and technical knowledge (e.g., 'know-what' and 'know-why') and DUI-mode is based on tacit knowledge and experience-based mode of learning (e.g., 'know-how' and 'know-who'), and combining the two modes of innovation leads to improved innovative performance in firms (Jensen et al. 2007).

The learning process in the context of external knowledge sourcing, or external learning, is described as a two-step process (Bierly and Daly, 2007). The 'boundary spanner' must first understand and appreciate the knowledge from an outside, from

the external source, and must be able to identify the uses for the knowledge within the firm. Secondly, the new knowledge from the external source needs to be transferred into the firm, where it must be integrated into the existing knowledge base of the firm and applied to new products or processes (Bierly and Daly, 2007). Referring to and building on the work of other authors in the literature on external learning, Bierly and Daly (2007) state that the boundary spanners need to be perceived as "technically competent and as having strong social and communication skills" (p. 47-48) as well as be able to explain new ideas to others in the firm. In addition, two barriers to external learning need to be overcome, which are the *not-invented-here* syndrome (associated with the resistance to change) and *lack of absorptive capacity*. Other issues examined by researchers in external learning are "difficulties associated with understanding and assimilating tacit knowledge from external sources, and the need for social connectedness to assist knowledge transfer" (Bierly and Daly, 2007; 48; referring to previous studies on external learning).

Smaller firms need to develop a wide knowledge base and scan for external sources to expand their expertise (Bierly and Daly, 2007). Bierly and Daly have identified four areas of barriers to learning from the academic community: 1) reluctance of the employee to read in company time; 2) difficulty in understanding, interpreting and applying the ideas found in journals or other codified knowledge sources; 3) difficulty in explaining the material and information to others with different expertise (i.e. dissemination of knowledge); and, 4) difficulty in integrating the new knowledge with the firm's existing knowledge base (2007).

Linking absorptive capacity to management practices, as in the ability of the firm' manager to internalize knowledge from external sources and utilize it in innovation processes, is bound to the characteristics and practices of the manager (da Mota Pedrosa et al., 2013). Absorptive capacity is tied to learning processes, and conceptualized as a knowledge creation process by Lane et al. (2006), where the phases of learning process are *exploration, transformation,* and *exploitation*. Activities related to exploration and exploitation are important to building knowledge (March, 1991), and 'transformation' links the exploration and exploitation through internal processes (da Mota Pedrosa et al., 2013). March (1991) defines exploration as organizational capabilities that include "search, variation, risk taking, experimentation, play, flexibility, discovery, innovation," whereas exploitation is understood as organizational capabilities of "refinement, choice, production, efficiency, selection, implementation, execution" (p. 71). In the context of knowledge creation, exploration is the identification and understanding of external knowledge, whereas transformation refers to maintaining and sharing new knowledge over time and combining it with existing knowledge (Lane et al., 2006; da Mota Pedrosa et al., 2013). In addition, exploitation is the last step of the process, which is the use and application of external knowledge in the organization's operations and innovation development (Lane et al., 2006; da Mota Pedrosa et al., 2013).

Todorova and Durisin (2007) propose that when firms do not possess knowledge related to the new knowledge, then transforming knowledge is necessary in order for the firm to change existing cognitive structures (i.e. mindset and organization of knowledge in order to learn and use it) and to allow integration of new knowledge (da Mota Pedrosa et al. 2013). *Self-motivation* and *open-mindedness* are the characteristics of the managers who explore external knowledge sources; important practices to transforming knowledge are informal and formal internal meetings, where managers communicate, promote and clarify the applicability of the new knowledge and its benefits and value to the firm (da Mota Pedrosa et al., 2013).

3.2.2. Barriers and the positive aspects of university-industry collaboration

From an academic's perspective, studies on academic's engagement with industry have focused on the *positive* aspects of collaboration (e.g., Lee, 2000; D'Este and Perkmann, 2011). Other studies have focused on the more *negative* aspects, such as barriers to collaboration (e.g. Bruneel et al., 2010; Tartari et al., 2012). The empirical research in the PhD study focuses primarily on the positive aspects – and the *successful* collaborations. However, if we take a look at the perceived gap that the GTNV-program bridges, there are several barriers identified in the context of SME-university interaction. As briefly introduced in the introduction-part of the dissertation (*chapter 1, section 1.4*), these are categorized as *system-based barriers* and *human-based barriers*. System-based barriers relate to institutional and infrastructural gaps, and human-based barriers relate to differences and distance between the actors. Therefore, the *perceived gap* is a combination of system-based as well as human-based barriers.

One system-based barrier is the lack of access to academic knowledge bases, and this includes lack of platforms (e.g., policies and frameworks) for SMEs to gain access to 'known' published knowledge from academia. Platforms for merely *matchmaking* firm and researcher is not sufficient, since many SMEs with no prior experiences of university collaborations need support and guidance to engage in this type of innovation activity. The non-existing incentive structure for academic researchers employed at the universities to engage with firms – especially SMEs – is anothor system-based barrier for the university-industry interaction. This means that, from academic researcher's perspective, it is not attractive to collaborate with SMEs on relatively short-term innovation projects without (direct) opportunities for publications.

Human-based barriers are bound in the perceived distance and existing *differences* between the actors' daily activities and behaviors. The differences contribute to the perceived distance are identified to be rooted in prejudices on each other's worldviews. The human-based factors are differences including various organizational cultures, time horizons, educational background, communication, and different competence levels (e.g., Davenport et al., 1999; Iles and Yolles, 2002;

Perkmann and Salter, 2012; Tartari et al., 2012). According to Davenport et al. (1999), cultural differences between industry and university would have a positive impact on the development of 'competence trust'. These variations in backgrounds and activity orientation of the interacting actors are identified as positive attributes to the innovation process and outcome of the collaboration.

Research indicates that, from a firm's perspective, barriers relating to the differences in the orientations of university and industry are lowered by prior experience and breath of interaction, and greater levels of trust reduce both the transactional and orientation barriers to collaborating with universities (Bruneel et al., 2010). Trust will evolve incrementally, according to Davenport et al. (1999), from repeat relationships between the same partners. Therefore, interaction and communication between the involved actors in the innovation process is crucial. In fact, human-based barriers are diminishing when the individuals from the firms and academic researchers meet and interact in the initial phases – in the successful cases. Inherently, the independent third party in the GTNV-model has a role to assist in mitigating human-based barriers by facilitating the process, conflicts, and other issues between the firm and academic researcher. Hence, human interaction and relationship-building between the two parties is essential for overcoming human-based barriers of the *perceived* gap. Only through interaction can the human-based barriers be overcomed.

Therefore, *human-based barriers* can be mitigated through trust- and relationship-building mechanisms, whereas *system-based barriers* are rooted in institutional and *infrastructural* (i.e., policy) mechanisms. The GTNV-program overcomes system-based barriers by providing the framework to narrow the distance between the SMEs and academic researchers, and making it attractive for the actors involved by co-financing the innovation projects thorugh regional and EU funds. The GTNV-program was mainly designed for academic researcher whom do not focus merely on publishing, but whom want incorporate lessons learned in teaching, get inspiration for empirical research, as well as networking with different types of SMEs. GTNV also overcomes human-based barriers, as the focus of the program is to facilitate the process of interacting face-to-face. Human-based barriers to collaboration are slowly broken down by the initial interaction with the operator at the university followed by the completion of the innovation project through interactive processes, which are facilitated by an independent third party.

The importance of trust to overcome academics' barriers to collaboration suggests that the human interaction and personal relationships creates and sustains links between industry and academics (Tartari et al., 2012). The perceived barriers to collaboration are lower for academics who trust their industry partner; personal and professional experience is shaping the minds of academics and thereby mitigating barriers to collaborate (Tartari et al., 2012). From a firm's perspective, the barriers related to the differences in the orientations of university and industry are lowered by prior experience and breath of interaction; greater levels of trust reduce both the

transactional and orientation barriers to collaborating with universities (Bruneel et al., 2010).

In addition, collaborative relationships are dynamic in nature with interactions that are built on *multi-dimensional trust* (i.e., competence, contractual, goodwill) (Davenport et al., 1999). Top three collaboration success factors, according to a study by Davenport et al. (1999), are *mutual respect and trust amongst partners*, *top managerial commitment from all parties*, and *clear understanding of each partners' responsibilities and tasks*. Interestingly, *Knowledge of partner prior to start of collaboration* was ranked second to last in their study. Nonetheless, trust will emerge through *repeat* collaboration with the same partner (Davenport et al., 1999).

Collaborating with external actors can be a source of innovation (Drucker, 1985) and an input for continuously learning, which affects the firm's ability to continuously improve and innovate (e.g., Boer and Bessant, 2004), i.e. continuous innovation. *Continuous innovation* is the firm's ability to combine operational effectiveness and strategic flexibility that includes innovation excellence (Boer and Gertsen, 2003; Boer, 2015). According to Boer and Gertsen (2003), strategic flexibility is "the capability to develop new configurations of products, market approaches, processes, technologies and competencies, organisation and management systems that enable the satisfaction of (the-day-after-) tomorrow's customers," and this requires *exploration* capabilities (p. 806). Whereas, operational effectiveness is "the capability (embedded in the configuration of products, market approaches, processes, (human) competencies, technologies, organisation and management systems) to satisfy today's customers' demands in terms of function, price, time, quantity, and place," which requires *exploitation* capabilities (Boer and Gertsen, 2003; 806).

Essentially, these are contrasting modes of knowledge creation and acquisition; exploration refers to learning and innovation by acquiring new knowledge, whereas exploitation refers to the use of existing knowledge (Conway and Steward, 2009). Studies show that collaboration with universities and research institutes are more explorative in nature, leading to possible radical innovations, whereas collaboration with suppliers and customers are more exploitative and thus more valuable for incremental innovation (e.g., Bengtsson et al., 2015).

Nevertheless, managers know innovation is the ticket to successful growth, but they cannot seem to get it right, but if the managers understand theories of innovation, they have the ability to create new-growth businesses repeatedly (Christensen et al., 2003). Christensen et al. (2003) state that "… But theory is eminently practical. Managers are the world's most voracious consumers of theory. Every plan a manager makes, every action a manager takes, is based on some implicit understanding of what causes what and why" (p.3). However, managers use one-size-fits-all theory too often, which is a problem in changing and uncertain environments (Christensen et al., 2003).

The three major options to create new capabilities are through acquisition, within the organization, and with spin-outs (Davenport et al., 2006). Processes are very hard to change, but to create new capabilities within an organization, "new team boundaries enable or facilitate new patterns of working together that ultimately can coalesce as new processes – new capabilities for transforming inputs into outputs" (Davenport et al., 2006; 381).

Firms that are unable to create growth is not necessary because they are not generating enough ideas, the problem lies in their processes and not their creativity (Christensen et al., 2003). As the authors state, focus should be on *pattern recognition* rather than data-driven market analysis. From a business model perspective, firms need to develop *roots* and *wings*. Roots are the sense of identity and commitment to established business models, whereas wings are the firm's ability to change, evolve, and create new business models. Wings include organizational capabilities that enable the firm to change and innovate, to build on the past but also advance beyond history to maintain relevance in a changing world (Davenport et al., 2006). Tushman and O'Reilly (2006) call this an *ambidextrous* organization, where managers must be able to implement radical and incremental change – to explore and to exploit at the same time. In essence, ambidextrous managers (Tushman and O'Reilly, 2006). Arguably, the role of managers is, among other, to reconfigure and develop new capabilities – innovation and dynamic capabilities (e.g., Teece, 2007).

To understand how firms can effectuate strategic change for survival, we need to understand how firms can develop and apply certain capabilities. The following section and several sub-sections dive into the vast literature on dynamic capabilities. Dynamic capabilities within the field of strategic management is a complex body of literature, which overall argues for the cornerstones of firms' survival and growth based on certain capabilities and their microfoundations. Although it is very difficult to observe dynamic capabilities in an empirical setting, it is an essential concept s the motivation of the PhD projects is rooted in exploring how SMEs can grow and create growth, and therefore the concept of dynamic capabilities is integrated into this study.

3.3. Dynamic capabilities: Resources, capabilities, and microfoundations

The field of strategic management is predominantly concerned with how firms generate competitive advantage and the understanding of the sources of sustained competitive advantage (Barney, 1991; Ambrosini and Bowman, 2009). In strategic management there are different views explaining the sustainable competitive advantage of firms, including the *resource-based* view and the *dynamic capabilities* view (e.g., Barney, 1991; Teece et al., 1997).

The resource-based view is a static view and argues that resources that are valuable, rare, imitable, and non-substitutable are sources of competitive advantage (Barney, 1991). The underlying assumption is that resources are heterogeneous across organizations and thus a firm can sustain competitive advantage over time. However, the resource-based view puts little weight on entrepreneurship, innovation, or learning (Teece, 2014).

The dynamic capabilities view is an extension of the resource-based view, as it addresses how future valuable resourced could be created; it is about understanding a firm's survival and growth (Ambrosini and Bowman, 2009). The knowledge-based view (Grant, 1996a, 1996b) and the core competencies perspective (Prahalad and Hamel, 1990) are also considered as extensions of the resource-based view (Ambrosini and Bowman, 2009). As Eisenhardt and Martin (2000) point out, terms for the same concept used by other authors are combinative capabilities (Kogut and Zander, 1992), architectural competence (Henderson and Cockburn, 1994), and capabilities (Amit and Schoemaker, 1993).

The dynamic capability perspective is rooted in *evolutionary economics* and the notion of *routines* (Nelson and Winter, 1982). The literature on dynamic capabilities also draws on behavioral theories (Cyert and March, 1963), learning theories (Cohen and Levinthal, 1990), theory of the growth of firms (Penrose, 1959), and creative destruction (Schumpeter, 1934). As Zahra et al. (2006) describe it, based on the Penrosian resource-based view, the behavioral and learning theories of organizational change acknowledge the decision-making process to change as "dependent on the willingness to change, the awareness of the need to change, and the perceived capacity to change effectively" (p. 927). Organizational capacities develop through learning from repeated trials, according to learning theories (Cohen and Levinthal, 1990; Zahra and George, 2002; Zahra et al., 2006).

Authors elaborate conceptually on what dynamic capabilities are, the role of managers, and they provide several (and sometime contradictory) definitions to the concept of dynamic capabilities. Here is a selected list of definitions:

- "The firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments." (Teece et al., 1997; 516)
- "The firm's processes that use resources—specifically the processes to integrate, reconfigure, gain and release resources—to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die." (Eisenhardt and Martin, 2000; 1107)
- "A dynamic capability is a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness." (Zollo and Winter, 2002; 340)
- "Defining ordinary or 'zero-level' capabilities as those that permit a firm to 'make a living' in the short term, one can define dynamic capabilities as those that operate to extend, modify or create ordinary capabilities." (Winter, 2003; 991)
- Dynamic capabilities are "the abilities to reconfigure a firm's resources and routines in the manner envisioned and deemed appropriate by the firm's principal decision-maker(s)." (Zahra et al., 2006; 918)
- "A dynamic capability is the capacity of an organization to purposefully create, extend, or modify its resource base." (Helfat et al., 2007; 4)

The definition of dynamic capabilities by Helfat et al. (2007) is applied in the empirical research. Furthermore, Teece (2007) proposes a framework that disaggregates dynamic capabilities into *sensing, seizing,* and *transforming*. In other words, the capacity to sense and shape opportunities and threats, to select and seize opportunities, and to manage threats and reconfigure the firm's resources in order to transform over time. Teece describes the aim with the framework:

> "The ambition of the dynamic capabilities framework is nothing less than to explain the sources of enterprise-level competitive advantage over time, and provide guidance to managers for avoiding the zero profit condition that results when homogeneous firms compete in perfectly competitive markets. A framework, like a model, abstracts from reality. It endeavors to identify classes of relevant variables and their interrelationships. A framework is less rigorous than a model as it is sometimes agnostic about the particular form of the theoretical relationships that may exist." (Teece, 2007; 1320)

Before discussing what dynamic capabilities are and how they are linked to other organizational processes, the following lists outline descriptions on *resources* and *capabilities*, as described by researchers in the strategic management field.

In general, a *resource* and *resource base* in the dynamic capabilities view:

- Resources consists "of knowhow that can be traded (e.g., patents and licenses), financial or physical assets (e.g., property, plant and equipment), human capital, etc." (Amit and Schoemaker, 1993; 35)
- "… refers to an asset or input to production (tangible or intangible) that an organization owns, controls, or has access to on a semi-permanent basis." (Helfat and Peteraf, 2003; 999)
- "The 'resource base' of an organization includes tangible, intangible, and human assets (or resources) as well as capabilities which the organization owns, controls, or has access to on a preferential basis." (Helfat et al., 2007; 4)
- "Resources are firm-specific assets that are difficult if not impossible to imitate;" *assets* that are "difficult to transfer among firms because of transactions costs and transfer costs, and because the assets may contain tacit knowledge." (Teece et al., 1997; 516)
- "Resources are potentially productive tangible and intangible assets and people that are semipermanently attached to a firm." (Teece, 2014; 340)

A *capability*, according to the literature:

- "A capability, whether operational or dynamic, is the ability to perform a particular task or activity." (Helfat et al., 2007; 1)
- "The literature is clear that capabilities are processes." (Ambrosini and Bowman, 2009; 34)
- Capabilities "refer to a firm's capacity to deploy resources, usually in combinations, using organizational processes, to effect a desired end." (Amit and Schoemaker, 1993; 35)
- "The concept of a capability as a set of routines implies that in order for the performance of an activity to constitute a capability, the capability must have reached some threshold level of practiced or routine activity. At a minimum, in order for something to qualify as a capability, it must work in a reliable manner. Taking a first cut at an activity does not constitute a capability." (Helfat and Peteraf, 2003; 999)

Organizational capability, as described by researchers in the field of dynamic capabilities:

- "Organizational capabilities enable an organization to earn a living in the present." (Winter, 2003 in Helfat et al., 2007; 1)
- "… refers to the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result." (Helfat and Peteraf, 2003; 999)
- "… is a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type." (Winter, 2003; 991)

An organizational capability is an outcome of knowledge integration, which are "complex, team-based productive activities" that are dependent on the firm's "ability to harness and integrate the knowledge of many individual specialists" (Grant, 1996b; 116).

Abell et al. (2008) suggest a definition of capabilities and routines, and how they relate, "A firm can be described as possessing the capability to realise a routine to the degree that it can repeatedly internalize a pattern of individual level external productivity effects," basically that a capability is to realize a routine (p. 29).

Finally, managerial and organizational processes "refer to the way things are done in the firm, or what might be referred to as its routines, or patterns of current practice and learning." (Teece et al., 1997; 518). Teece et al. (1997) state that organizational processes have three roles: the static concept of coordination/integration; a more dynamic concept of learning; and, a transformational concept of reconfiguration.

3.3.1. What are dynamic capabilities?

As Teece (2007) states, "Dynamic capabilities include difficult-to-replicate enterprise capabilities required to adapt to changing customer and technological opportunities" (p.1319), as well as these capabilities "embrace the enterprise's capacity to shape the ecosystem it occupies, develop new products and processes, and design and implement viable business models" (p. 1320).

Dynamic capabilities are processes or routines that alter the resource base (Eisenhardt and Martin, 2000; Helfat et al., 2007; Ambrosini and Bowman, 2009); capabilities are concerned with change (Winter, 2003), adaptation (Teece et al., 1997; Helfat and Peteraf, 2003; Helfat et al., 2007; Teece, 2007) or to create market (Eisenhardt and Martin, 2000) or shape the ecosystem (Teece, 2007).

The use of dynamic capabilities is an intentional and deliberate effort to change the firm's resource base (Zahra et al, 2006; Helfat et al., 2007; Ambrosini and Bowman, 2009). Dynamic capabilities are not resources; they are processes that impact upon resources, and the value of dynamic capabilities derives from their outputs, thus the creation of a new set of valuable resources (Ambrosini and Bowman, 2009).

The role of managers is changing the resource base and deploying dynamic capabilities, which are firm-level capabilities (Eisenhardt and Martin, 2000; Zahra et al., 2006; Helfat et al, 2007; Teece, 2007; O'Reilly and Tushman, 2008; Ambrosini and Bowman, 2009; Augier and Teece, 2009). Dynamic capabilities do not lead directly to competitive advantage (Eisenhardt and Martin, 2000; Helfat et al., 2007). In sum, "dynamic capabilities are best conceptualized as tools that manipulate resource configurations" (Eisenhardt and Martin, 2000; 1118).

3.3.2. Categories of capabilities

In the literature, typologies of capabilities are developed (e.g. Collis, 1994; Winter, 2003; Zahra et al., 2006); however, as Winter (2003) pinpoints, there is a broad consensus in the literature that *dynamic* and *ordinary* capabilities are distinguish by the fact that dynamic capabilities are concerned with change. Ordinary capabilities operate, administrate and govern, whereas dynamic capabilities are sense, seize and transform (Teece, 2014). Collis (1994) discusses four categories of capabilities including higher-order capabilities or *meta-capabilities*, which are described as "the capability that wins tomorrow is the capability to develop the capability to develop the capability that innovates faster (or better), and so on" (p. 148). Winter (2003) calls them *higher capabilities* and *first-level capabilities*, which are the dynamic capabilities that modify and change *zero-level capabilities*, e.g. *operational* or *ordinary* capabilities that essentially are the "'how we earn a living now' capabilities" (p. 992).

Zahra et al., (2006) differentiates between *substantive* and *dynamic*. A substantive capability is the firm's ability to produce desired, tangible or intangible, output, e.g. the firm's ability to solve a problem or to develop a new product. Whereas, a dynamic capability, that is a higher-order capability, is the firm's ability to manipulate their substantive capabilities, e.g. the ability to change the way that the firm solves its problems or to reform the way the firm develops new products (Zahra et al., 2006).

Ambrosini et al.'s (2009) typology of dynamic capabilities compares *the resource base* to, for instance, Zahra et al.'s (2006) substantive capabilities and Winter's (2003) zero-level capabilities. The dynamic capabilities are classified as *incremental, renewing*, and *regenerative*, where the latter are compared to Collis' (1994) meta-capabilities and Winter's (2003) higher order capabilities. Incremental and renewing capabilities are, according to Winter's (2003) classification, first-order capabilities (Ambrosini et al., 2009).

An “operational capability enables a firm to perform an activity on an on-going basis using more or less the same techniques on the same scale to support existing products and services for the same customer population,” and thus an operational capability aims to maintain status quo (Helfat and Winter, 2011; 1244). Contrary, dynamic capabilities enable firms to alter how they make their living (Helfat and Winter, 2011).

Zahra and George (2002) recognize absorptive capacity as a dynamic capability. The authors claim that the four organizational capabilities of *knowledge acquisition*, *assimilation, transformation,* and *exploitation* build on each other to yield absorptive capacity. According to Zahra and George (2002), it is a dynamic capability that “influences the nature and sustainability of a firm's competitive advantage” (p.185) and “influences the firm's ability to create and deploy the knowledge necessary to build other organizational capabilities (e.g., marketing, distribution, and production)” (p.188). The authors distinguish between *potential absorptive capacity* (i.e., acquisition and assimilation) and *realized absorptive capacity* (i.e., transformation and exploitation). Firms and individuals with prior related knowledge may have greater absorptive capacity (Cohen and Levinthal, 1990).

Nonetheless, the single largest source of confusion in the concept of dynamic capabilities is the lack of agreement about whether a dynamic capability refers to substantive (ordinary or operational) capabilities in volatile environments or to the firm’s ability to alter existing substantive (ordinary or operational) capabilities, regardless of the volatility of the environment (Zahra et al., 2006).

Ambrosini and Bowman (2009) pinpoint some misconceptions in the literature. First, dynamic capabilities can operate in relatively stable environments and thus *dynamic* does not refer to environmental dynamism. Second, dynamic capabilities themselves to not change over time, i.e. the capabilities are not dynamic. The authors argue that *dynamic* refers to change in the resource base.

3.3.3. Linking dynamic capabilities to success

The performance of dynamic capabilities can be evaluated through *evolutionary fitness*, which “refers to how well a dynamic capability enables an organization to make a living by creating, extending, or modifying its resource base” (Helfat el al., 2007; 7), and the *technical fitness* of “how well a capability performs its intended function” (Helfat et al., 2007; 7). Evolutionary fitness is *doing the right things*, whereas technical fitness is *doing it right* (Ambrosini and Bowman, 2009; Teece, 2014). According to Teece (2007), “Dynamic capabilities assist in achieving evolutionary fitness, in part by helping to shape the environment,” which is entrepreneurial in nature (p. 1321). In addition, technical fitness is about *efficiency* and evolutionary fitness is *innovation* (Teece, 2014).

Although dynamic capabilities are developed in order to realize strategic advantages, this does not mean that their development ensures organizational success (Zahra et al., 2006), as "their commonalities imply that dynamic capabilities per se are not likely to be sources of sustained competitive advantage" (Eisenhardt and Martin, 2000; 1110). Eisenhardt and Martin state that, "Effective dynamic capabilities are necessary, but not sufficient, conditions for competitive advantage" (2000; 1117). They indirectly contribute to the output of an organization through an impact on operational capabilities, and therefore dynamic capabilities do not directly affect the output (Helfat and Peteraf, 2003).

Alternatively, as Zahra et al. (2006) put it, "the possession of dynamic capabilities per se does not necessarily lead to superior performance" (p. 924) or successful outcomes; or vice versa, successful outcomes does not mean that the firm possesses dynamic capabilities. The resource configurations that managers build using dynamic capabilities are the sources of long-term competitive advantage, not dynamic capabilities themselves (Eisenhardt and Martin, 2000). Similarly, as Ambrosini et al. (2009) state:

> "In other words, the resource base is directly linked to rents, but dynamic capabilities are one step beyond (and regenerative dynamic capabilities two steps beyond) these rent generating activities. Incremental and renewing dynamic capabilities impact on the resource base, and regenerative dynamic capabilities in turn affect incremental and renewing dynamic capabilities. The impact of dynamic capabilities on ultimate firm performance may be negative; the dynamic capabilities may change the resource base but this renewal may not be in line with the environment." (Ambrosini et al., 2009; S20)

3.3.4. Learning and best practice

Dynamic capabilities are learned, stable and systematic patterns of collective activity, and the development thereof are bound in repeated practice, which is an important learning mechanism (Eisenhardt and Martin, 2000; Zollo and Winter, 2002). It must have a *patterned element*, must be *repeatable*, and be concerned with *change* (Zollo and Winter, 2002; Winter, 2003). Ad-hoc problem solving is a way to change, but it is not a dynamic capability and neither is brilliant improvisation (Winter, 2003). Zollo and Winter (2002) link learning mechanisms to the evolution of dynamic capabilities and argue that the learning mechanisms that are involved in the creation and evolution of dynamic capabilities are *experience accumulation*, *knowledge articulation*, and *knowledge codification*. Authors state that a balance between thinking and doing, between explicit learning activities (exploration) and execution activities (exploitation), is essential (March, 1991; Zollo and Winter, 2002).

Eisenhardt and Martin (2000) argue that dynamic capabilities "exhibit commonalities across effective firms or what can be termed 'best practice'" (p.1106). They state that "the functionality of dynamic capabilities can be duplicated across firms, their

value for competitive advantage lies in the resource configurations that they create, not in the capabilities themselves" (Eisenhardt and Martin; 1106). This suggests that dynamic capabilities do not have to be firm specific (Eisenhardt and Martin, 2000; Ambrosini and Bowman, 2009). "While dynamic capabilities are certainly idiosyncratic in their details, the equally striking observation is that specific dynamic capabilities also exhibit common features that are associated with effective processes across firms" such as executing dynamic capabilities (processes or routines) of product development, strategic decision making, and knowledge brokering (Eisenhardt and Martin, 2000; 1108).

In contrast, Teece (2014) differentiates between key routines in ordinary capabilities as being best practices, whereas for dynamic capabilities those are *signature processes*. This contrast signals the tension between the 'Eisenhardt cluster' and 'Teece cluster' of research on dynamic capabilities. Teece (2014) claims that Eisenhardt and Martin (2000) are focusing on ordinary capabilities when arguing for best practices of dynamic capabilities across firms; thus, they have reframed or misinterpreted the dynamic capabilities framework "by claiming that all capabilities, including dynamic capabilities, can ultimately be characterized by best practice and hence imitated" (Teece, 2014; 342). Peteraf et al. (2013) tries a contingency-based approach to unify the field with the two separate domains of knowledge (e.g. two clusters) by stating that there are certain conditional cases where dynamic capabilities may enable firms to attain a sustainable competitive advantage. They also argue that "despite the many commonalities among best practices, nontrivial competitive advantages may still be possible due to differences in experience, competitive context, added value, and timing" (Peteraf et al., 2013; 1406). According to Helfat and Winter (2011), new product development that alter the ways in which a firm earns its living is a dynamic capability.

Additionally, dynamic capabilities also include other, more general, actions that foster coordination and organizational learning (O'Reilly and Tushman, 2008). Other dynamic capabilities related to the gain and release of resources are *knowledge creation routines and processes*, which are essential dynamic capabilities (Eisenhardt and Martin, 2000). This type of dynamic capability has a very specific purpose and support a very specific activity (Winter, 2003; Helfat et al., 2007; Helfat and Winter, 2011).

Eisenhardt and Martin state, "A common feature across successful knowledge creation processes is explicit linkage between the focal firm and knowledge sources outside the firm…. [, and] these linkages were a small number of 'gatekeepers' within the firm" (2000; 1109). Dynamic capabilities notably involve the creation of new, situation-specific knowledge, and this occurs through experiential actions to learn quickly, which includes the use of prototyping and early testing to gain new knowledge quickly (Eisenhardt and Martin, 2000). Capabilities – dynamic or ordinary – underscore that learning and knowledge creation processes are vital.

3.3.5. Development and deployment of dynamic capabilities

The triggers for developing and deploying dynamic capabilities are *coordination, selection,* and *combination*, which are "important dimensions of the process of integration; these enable the firms to build its dynamic capability to reconfigure their substantive capability routine" (Zahra et al., 2006; 929). Routines are patterns of interaction, which resides in group behavior, and these represent successful solutions to particular problems; however, particular subroutines may reside in individual behavior (Teece et al., 1997). Teece et al. (1997) build on previous research indicating that collaborations can be a vehicle for new organizational learning, as external sources may assist the firm in recognizing dysfunctional routines or prevent strategic blind spots in firms.

Building on Penrose (1959), Zahra et al., (2006) claim that perception of opportunities, willingness to change, and ability to implement changes – of the entrepreneur, the entrepreneurial team, or the firm's senior – correspond to the creation and application of dynamic capabilities in the firm. The authors argue that in order to gain organizational performance-related benefits, the managements of the dynamic capabilities is crucial. Thus, entrepreneurs and managers are at the center of the process by which firms give birth to substantive (ordinary or operational) capabilities and develop the dynamic capabilities to transform them over time (Zahra at al., 2006).

In part, dynamic capabilities reside with top management and individual managers, who have *dynamic managerial capabilities*, which are "the capabilities with which managers build, integrate, and reconfigure organizational resources and competences" (Adner and Helfat, 2003; 1012). The three underlying factors or attributes of dynamic managerial capabilities are *managerial human capital* that refer to learned skills requiring some investment in education, training or learning, *managerial social capital* results from social relationship, social ties and their goodwill, and *managerial cognition* which refer to managerial beliefs and mental models as a foundation for decision-making (Adner and Helfat, 2003; 1020-1021).

Helfat and Peteraf (2003) provide a framework that links the strands of routine-based (e.g. Nelson and Winter, 1982), resource-based (e.g. Teece et al., 1997), and knowledge-based (e.g. Grant, 1996a, 1996b) theories, and claim that all capabilities have the potential to accommodate change, but some may deal specifically with learning, adaptation, and change processes. This framework of capability lifecycle is a dynamic resource-based view and argues that the evolution of organizational capability resides within teams, which constitute of human capital (e.g., knowledge, experience, and skills), social capital (e.g., social ties) and cognition (Helfat and Peteraf, 2003). The authors propose framework with branches – the *six R's of capability transformation* – which are *retirement, retrenchment, renewal, replication, redeployment*, and *recombination* (Helfat and Peteraf, 2003).

Capability development may drive new strategy, as managers "see the potential for a new strategic direction in the process of exercising new capability development" (Zahra et al., 2006; 944). In part, capabilities develop through practice (Helfat and Peteraf, 2015). New challenges and new situations bring about opportunities for organizational learning and thereby "setting a foundation for creating dynamic capabilities," and the authors claim that the greatest learning may occur through *conscious experimentation*, rather than through unanticipated events (Zahra et al., 2006; 945).

Furthermore, *ambidexterity* is "the ability of a firm to simultaneously explore and exploit," and O'Reilly and Tushman (2008) argue that it acts as a dynamic capability and helps firms to sense and seize new opportunities (p.185). Building on March's (1990) view on exploration and exploitation, the authors state that a clear articulation about the capabilities that facilitate exploration and exploitation is missing (O'Reilly and Tushman, 2008). Adner and Helfat (2003) and O'Reilly and Tushman (2008) highlight research on dynamic capabilities that documents top management's influence (e.g. Rosenbloom, 2000; Tripsas and Gavetti, 2000).

Additionally, the key ingredient to NCR Corporation's successful transformation was the management's ability to develop dynamic capabilities and thus a central element (Rosenbloom, 2000; Adner and Helfat, 2003; O'Reilly and Tushman, 2008). In contrast, senior management cognition's hindered the development of new capabilities in Polaroid (Tripsas and Gavetti, 2000; O'Reilly and Tushman, 2008); and, the ability of Oticon (a Danish-hearing-aid company) to continually innovate was a function of knowledge creation and knowledge integration (Verona and Ravasi, 2003; O'Reilly and Tushman, 2008).

Knowledge creation is the ability to sense new technological opportunities, and knowledge integration is the ability to seize and implement these advantages through organizational processes and structures (O'Reilly and Tushman, 2008). Moreover, new product development could possibly be a manifestation of innovation, but this is not equivalent to organizational adaptation; thus, ambidexterity as a critical mechanism for organizational adaptation is not equal to new product development (O'Reilly and Tushman, 2008).

Zahra et al. (2006) highlight, through their review of the literature, that the dynamic capabilities view is primarily based on research and theory building on established firms, and the authors argue for a need to focus on dynamic capabilities in new ventures and SMEs. In a recent study, Helfat and Winter (2011) pinpoint that smaller firms need to avoid overhead burdens of costly dynamic capabilities by temporarily reallocating resource from ordinary capabilities to change-oriented project teams.

Nevertheless, the challenge for new and established firms is to create "a systematic openness to upgrading and revising their substantive capabilities" (Zahra et al., 2006; 945) through various learning modes – one could be collaborative processes with external knowledge sources.

Easterby-Smith et al. (2009) state that dynamic capabilities can take a variety of forms, but the basic characteristic that these higher-level capabilities provide opportunities for *knowledge gathering and sharing*. More attention is needed on linking dynamic capabilities to more micro-level processes, such as search processes, as well as research methods need to include longitudinal studies (qualitative or quantitative) in order to provide a better insight into the practice of dynamic capabilities (Easterby-Smith et al., 2009).

In order to integrate knowledge from external sources, firms and their managers need to develop and apply *relational capabilities*, which is the capacity to purposefully create, extend, or modify the resource base of the firm by including external resources (Helfat et al., 2007). Brokers, which are addressed in a later section and researched empirically, can arguably play a role in assisting a firm to develop and apply relational capabilities through the mechanism of collaborative innovation projects.

3.3.6. Microfoundations of dynamic capabilities

Teece (2007) describes the microfoundations of dynamic capabilities as "distinct skills, processes, procedures, organizational structures, decision rules, and disciplines" (p. 1319). For analytical purposes, Teece disaggregates dynamic capabilities into the capacity to "(1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets" (2007; 1319).

The microfoundations that undergird firm-level "sensing, seizing, and reconfiguring capacities are difficult to develop and deploy" (Teece, 2007; 1319). In his work, Teece recognizes top management and their cognition as microfoundations of dynamic capabilities (Helfat and Peteraf, 2015). Foundational for dynamic capabilities is the firm's capacity has "to create, adjust, hone, and, if necessary, replace business models" (Teece, 2007; 1330). Additionally, successful firms need to build and apply all three classes of capabilities – *sensing, seizing,* and *transforming* – simultaneously, and these reside with top management (Teece, 2007).

Search processes within the business ecosystem should include potential collaborators, such as customers, suppliers, and complementors (e.g., universities) that participate in innovation activities (Teece, 2007). When new opportunities – technological or market – is sensed and shaped, the firm must address this opportunity through new products, processes, or services (Teece, 2007). Managing threats is essentially about reconfiguring resources in order to maintain evolutionary fitness (Teece, 2007).

Helfat and Peteraf (2015) build on Teece's (2007) framework of sensing, seizing and reconfiguring (or transforming), and focus on the microfoundations at the level of

the *individual manager*. The authors illustrate *managerial cognitive capabilities*, for analytical purposes, as microfoundations of dynamic managerial capabilities: *perception and attention* as microfoundations for sensing; *problem-solving and reasoning* as microfoundations for seizing; and, *language and communication*, as well as *social cognition*, as microfoundations of reconfiguring (Helfat and Peteraf, 2015). They define the concept of managerial cognitive capability as "the capacity of an individual manager to perform one or more of the mental activities that comprise cognition" (Helfat and Peteraf, 2015; 835).

Microfoundations have become an essential emerging theme in strategic management, according to Abell et al. (2008). The authors argue that attention needs to be on explanatory mechanisms located at the micro-level, which is the level of individual action and strategic interaction. Abell et al. (2008) claim that complicated patterns of individual actions and interaction are best understood at micro-level.

According to Felin and Foss (2009), there is a lack of work on the origins of organizational routines and capabilities, and their microfoundations. *Intentionality* and *managing exceptions*, and other underlying dynamics of organizational activity, are areas of future work; these include individual behavior such as decision-making and interaction at the individual-level (Felin and Foss, 2009).

As mentioned in the previous subsection, brokers may play a role in building the microfoundations of dynamic capabilities, including relational capabilities. This is dicussed in the *chapter 5*. This following section in the literature review addresses the roles of brokers in innovation processes.

3.4. Knowledge brokers and brokering in innovation processes

Knowledge brokers and *intermediaries* have a role in innovation processes by being in between and bridging worlds (Hargadon, 2003; Chesbrough, 2006; Howells, 2006), as "Knowledge is imperfectly shared over time and across people, organizations, and industries. Ideas from one group might solve the problems of another, but only if connections between existing solutions and problems can be made across the boundaries between them" (Hargadon and Sutton, 1997; 716).

Brokers and intermediaries are often used interchangeably. Some authors refer to intermediaries as a broader term and argue that intermediaries may function as brokers (Iles and Yolles, 2002; Chesbrough, 2006; Roxas et al., 2011), as well as internal roles of 'boundary spanner' and 'gatekeepers' may act as intermediaries (Allen, 1977; Tushman, 1977; Etzkowitz et al., 2000; Conway and Steward, 2009). An intermediary is "an all-inclusive term that includes a company that delivers an innovative service to a customer in a variety of industries" (Gassmann et al., 2011; 458) with the main value proposition of bridging the gap between internal and external know-how (Burt, 1992; Gassmann et al. 2011). In addition, the intermediary roles bridge the managerial gap, and consultants, who may perform a range of bridging activities, including building linkages with the external knowledge system, can help "bridge the gap between technological opportunity and user needs" (Bessant and Rush, 1995; 101).

Knowledge brokers as firms or individuals who are in between two disconnected groups, thus spanning multiple markets and technology domains, they innovate by brokering knowledge – transferring ideas – from where it is known to where it is not (Hargadon, 1998). In this view, innovation is a result of *synthesizing* and *bridging ideas* from different domains that depend on exploiting the past; "Extraordinary innovations are the result of simultaneously thinking in multiple boxes, not of the oft-prescribed 'thinking outside the box'. In short, extraordinary innovations are often the result of recombinant invention," and innovation is as much *social* as it is *technical*, thus products of groups and not lone inventors (Eisenhardt, 2003; viii). Innovations that rely on the past are pragmatic, as they save managers and their developers' time and money (Eisenhardt, 2003).

In a literature review, Howells (2006) distinguishes between *intermediation as a process* and *the role of intermediaries* (i.e. organizations or individuals) in innovation processes. "Organizations identified as providing intermediary roles in innovation processes are complex and multiple entities, whose primary role may often not be as an intermediary" (Howells, 2006; 720). Howells provides a list of innovation intermediation functions, including *knowledge processing, generation and combination* to help combine and generate knowledge of two or more partners and work directly with clients on a one-to-one basis, and *gatekeeping and brokering* which includes matchmaking.

Knowledge brokers as firms or individuals innovate by "combining existing technologies in new ways that results in dramatic synergy," and firms are 'modern invention factories' with output consisting solely on innovative solutions to novel problems (Hargadon, 1998; 210). Hargadon (1998) gives the example of Edison, who often borrowed from the ideas of other industries, and where knowledge-spillover from one development project was exploited in other projects. *Access, learning, linking,* and *implementation* are activities underlying innovation by knowledge brokers (Hargadon, 1998). Resources from one context that are introduced in another context appear, and are, innovative; arguably, this is where the knowledge broker has an important role, to disentangle and recombine resources (Hargadon, 2002). Hargadon (2002) claims that "knowledge brokering organizations serve as windows into the relationship between learning and innovation because they routinely transform their past knowledge into new and innovative products, processes, and services" (p. 46); these firm act predominantly as consultants and move between multiple domains.

In sum, "Brokers build bridges among people, and thus between bodies of knowledge," as stated by Sverrisson (2001; 323). In a commentary by Meyer (2010), he infers on Sverrisson's (2001) article, that the "knowledge brokers can be understood as persons or organizations that facilitate the creation, sharing, and use of knowledge" (Meyer, 2010; 119). Drawing on work of Burt (1992, 1993), Sverrisson points out that "brokers are intermediaries, bridgemakers or negotiators, they facilitate and channel interaction, and sometimes they take part in it, sometimes they actually initiate it" (2001; 314).

3.4.1. Knowledge brokering, intermediation, and brokerage theories

Brokerage theories acknowledge the innovation process as one of recombining *people, ideas,* and *objects* – for recombinant innovation (Hargadon, 2003, 2014). As Hargadon (2002) pinpoints, the perspective of innovation as a recombination of past ideas, objects, and people is not new, and Schumpeter defined innovation as the "carrying out of new combinations" (1934; 252). Nonetheless, the preconditions for innovation is created by the larger social context through "the recombinant nature of innovation and the fragmented nature of the larger social structure"; firms and individuals exploit the fragmented social structure by bridging different and multiple domains (Hargadon, 2002; 43). Brokerage theories of innovation are inherently *process theories* that reflect the dynamic interaction between the three levels of the *individuals or small group*, the *organization*, and the *institutional structure* (Hargadon, 2014).

Brokerage theories focus on how managers recognize and recombine resources (Hargadon, 2014), and the challenge for managers is "to put in place the organizational capabilities to bridge distant worlds, in which lie potential valuable resources, and to build the new world in which new combinations will thrive"

(Hargadon, 2003; 205). Bridging distant worlds includes bridging 'thought worlds' (Dougherty, 1992) and 'social worlds' (Strauss, 1978). It is essentially about building links, pursuing 'weak ties' (Granovetter, 1973), and encouraging commitment that is based on 'doubt' and 'dedication'. In Hargadon's words, "Doubt in the small worlds of today, and dedication to building new ones in their place" (2003; 206).

In Kirkels and Duysters (2010), five types of brokerage are depicted. *Coordinator* is an insider who enhances interactions between members of the group he or she belongs to. *Gatekeeper*, as an insider, absorbs knowledge from a group and passes it to the group he or she belongs to. *Representative* diffuses knowledge from its own group to other groups. *Cosmopolitan*, as an outsider, mediates between members of the same group. Lastly, *liaison*, as an outside, enhances interaction between different groups.

According to Hargadon (2003), there are three *brokering strategies* for firms. The first strategy is a dedication of a whole firm to pursue innovation through brokering models, and therefore must find a position in a larger network or business ecosystem, which allows the firm to move from one world to another continuously. Hargadon and Sutton's (1997) discussion on technology brokering offers a perspective on innovation, which recognizes the value of *inventive combination* rather than merely *invention*. In their study on IDEO, a product development firm, Hargadon and Sutton (1997) argue that *access, acquisition, storage,* and *retrieval* are phases in their linear four-stage process model of how innovation occurs through technology brokering. Acquisition, storage, and retrieval (i.e., application of stored information) are IDEO's internal brokering routines, and thus brokers assist the transformation of ideas and knowledge (Hargadon and Sutton, 1997).

The second strategy of brokering involves the firm constructing smaller groups internally that are dedicated to bridging different worlds – also internal *thought worlds* (Dougherty, 1992) – in building recombinant innovation. The third strategy, according to Hargadon, is based on a decision "to develop the ability to recognize and seize one-time opportunities for brokering" (2003; 129). The firm moves knowledge and technologies of one world to another, as *single opportunities* that emerge, mostly unexpectedly and disappear rapidly. One example provided by Hargadon (2003) for the third strategy is Henry Ford and Co. recognizing the ideas from the machine tool industry, and creating the assembly line by building on observations from Singer sewing machines, meatpacking, and Campbell Soup. Thus, the knowledge brokering process require managers, individuals, and groups "to pursue learning in new domains, to seek the knowledge of others, and to share their knowledge with others" (Hargadon, 2002; 72).

3.4.2. Types of intermediaries, brokers, and their capabilities

Innovation intermediaries are not a new phenomenon and there is great variance of agents, who may provide a variety of functions (Roxas et al., 2011; Katzy et al., 2013). There are many terms for perhaps the same function as *middlemen*, including innovation intermediaries, knowledge brokers, technology transfer brokers, technology translators, innovation agents (Hargadon, 1998; Bessant and Rush, 2000; Iles and Yolles, 2002; Chesbrough, 2006; Roxas et al., 2011). Online market places, such as Innocentive, are intermediary platforms of market brokers that match customers and suppliers, i.e. innovation problem owners and solution providers (Katzy et al., 2013).

For instance, *innovation intermediaries*, as described by Chesbrough (2006), have a function of helping innovators use external ideas more rapidly, or a function of helping inventors find more markets where ideas can be used by external actors for mutual benefits. From a technology transfer perspective, technology transfer brokers are a type of innovation intermediary who facilitates the interactions, in a rather linear process, from donor to recipient, act as 'middlemen' and focus on lasting relationships with clients (Roxas et al., 2011). In technology transfer, the aim is to achieve a transaction between two parties (Chesbrough, 2006).

Lichtenthaler (2013) also identified different types of intermediation, including *passive, proactive,* and *reactive approaches* in either *inward* or *outward* technology transfer. He also found that the intermediaries' knowledge about the technology transfer process was one of the drivers, and on the other hand, the limited technology knowledge of the intermediaries complicated transactions. The majority of manufacturing firms in his study acknowledged the complementarity of intermediation to the firm's internal capabilities, and were thus willing to have a close collaboration with intermediaries in order to facilitate successful technology transfer. In his study, Lichtenthaler (2013) pinpoints the major managerial challenge by manufacturing firms as the identification of technology transfer opportunities; therefore, the potential value of intermediaries appears to be highest in *the initial stage*, which is followed by a supporting role in subsequent stages.

Furthermore, a quantitative research conducted by Roxas et al. (2011) found that focusing on a limited number of clients, such that the intermediary can provide long-lasting and customized support, has a positive effect on the performance of the technology transfer unit (e.g., inter-organizational network).

Moreover, innovation intermediaries can assist firms in their search for external knowledge and technologies; a complex task that requires new organizational processes (Chesbrough; 2006). Thus, innovation intermediaries can help firms search outside; however, as Chesbrough pinpoints, "there is no substitute for effective internal processes to do this" (p. 161), but firms may use intermediaries before committing substantial resources and reorganize internal processes. This is particularly interesting for SMEs, as they generally have limited resources – people,

time, and money. Nonetheless, firms need sufficient internal capabilities for managing technology transfer, including absorptive capacity and *desorptive capacity*, the latter defined as a firm's ability to externally exploit knowledge or outward technology transfer capability (Lichtenthaler and Lichtenthaler, 2009; Lichtenthaler, 2013).

According to Bessant and Rush (2000), the key role of *innovation agents* is to "enable, energize, or catalyze the process of technological change" and act "as information brokers, as sources of particular resources or capabilities, as integrating agents, as network facilitators, and as carriers of new learning about both technological competence and innovative capabilities" (p. 157). Bessant and Rush (2000) argue that SMEs generally do not have the capabilities required to fulfill these types of functions.

Intermediaries may help bridge the gap between needs and means within the innovation process, and as Bessant and Rush (2000) pinpoint, "intermediary support through innovation agents is not simple another term for consultancy activity" (p. 158). The authors argue that an alternative view to linear models of transferring expert knowledge from supplier to user is *process consulting*, which "involves a catalytic, non-directive approach, stressing learning and facilitation rather than prescription," and they emphasize building *long-term relationships* rather than one-time solution to a given problem (2000; 158). Innovation agents can improve the operation of innovation processes through expert consulting, experience-sharing, brokering (e.g. connecting different sources and users), diagnosis and problem clarification, benchmarking (e.g. identifying good practice), and change agency (Bessant and Rush, 2000).

Another type of knowledge brokers are *technology translators* who are also able to act as *facilitators of learning*, as they use interpersonal, creative, and functional skills, and thus helping SMEs to exploit the knowledge base of universities (Iles and Yolles, 2002). As Hargadon (2002) underscores:

> "All too often, solutions to a problem lie close by, but are obscured by the different context in which they were learned and, in organizations, by the different people who learned hem. For innovation, it's not what organizations already know that is important. It's how they use what they know to make sense of situations and how they use new situations to make sense of what they already know." (Hardagon, 2002; 80).

Roles of this type of supportive intermediary or knowledge broker facilitate "the SME's ability to identify, recognize, and validate knowledge in the KB [knowledge base of universities] and access it in a process of knowledge migration" (Iles and Yolles, 2002; 48). In addition, the translator may also help the SME in building on the knowledge migrated through a process of knowledge accommodation, assist the SME in applying knowledge throughout the firm, support a process of knowledgeable

action, and play a role in knowledge renewal and reconstructing the SME's knowledge base (Iles and Yolles, 2002).

Gassman et al. (2011) identify three types of intermediaries with different capabilities and different strengths along the three innovation phases – *abstraction, analogy, adaption* – which enable them to realize cross-industry innovation: *the innovation broadener, the innovation leverager*, and *the innovation multiplier*. According to Gassmann et al., (2011), in order for firm's to acquire, assimilate, transform, and exploit external knowledge (Zahra and George, 2002), the intermediaries have an important role as knowledge brokers:

> "From an absorptive capacity (Cohen and Levinthal, 1990) point of view, the *innovation broadener* facilitates knowledge acquisition and adaption (Zahra and George, 2002) even from distant industrial ambits. The *innovation multiplier* has its strength in supporting companies in the transformation of knowledge into an industrial ambit. The *innovation leverager* contributes to three phases of innovation (knowledge acquisition, knowledge adoption, and knowledge transformation)." (Gassmann et al., 2011; 466).

Katzy et al. (2013) identifies three strategic capabilities of innovation intermediaries as process coordinators: *matchmaking capability, innovation process management capability,* and *valuation and portfolio management capability*. The authors pinpoint that the engineering and execution of collaborative innovation processes through intermediaries are underdeveloped, both practically and conceptually.

3.4.3. Trust in innovation intermediation and a policy perspective

Collaborative relationships are dynamic in nature and the broker or intermediary has the role of providing a platform to enable the evolution of an on-going goodwill-based relationship, rather than merely supplying 'contractual trust' for a single transaction of collaboration (Davenport et al., 1999). Lichtenthaler (2013) underscores that *trust* is critical, and trust can be achieved by the means of repeated collaboration, in which the firm and intermediaries learn to collaborate over time.

Fleming and Waguespack (2007) claim that, "An inherent lack of trust associated with brokerage position can be overcome through physical interaction" (p. 165), and they argue, "trust developed through physical interaction will increase the likelihood that a broker will advance into leadership" (p. 169). As Dodgson (1993) states on the importance of establishing trust, "High trust is associated with respect for partner's abilities, commitment based on the belief of mutual benefit, and openness and honesty in objectives" (p. 92). Lee et al. (2010) suggest a network model with a trust-building intermediary as an effective way to facilitate open innovation among SMEs, and they argue that an intermediary can help an SME maximize its chances of innovation and increase its likelihood of success in developing new products and services.

Howells' (2006) study suggests that innovation intermediaries, from a policy perspective, provide value in terms of improving connectedness and bridging ties within an innovation system, as well as in their role of creating new possibilities and dynamism within an innovation system. Technology policy instruments across nations involve an intermediary institution or a so-called *honest broker* to facilitate the initial contact, thus bring together research institutions and firms; the aim is to initiate interactions that will result in productive relationship, also from an economic perspective (Davenport et al., 1999).

From a university perspective, individuals who are *interface specialists* act as intermediaries in facilitating interaction with potential partners in industry and governments and with other counterparts, as well as "make introductions, organize discussions, [and] negotiate contracts" (Etzkowitz et al, 2000; 316). According to Davenport et al.'s study on collaborative R&D projects between New Zealand industry and research institutions, the broker is playing a dual role; first by establishing contractual trust, and secondly validating competence trust at the beginning of the relationship (1999).

From a policy-level, instruments should be in place to provide the environment for developing goodwill trust. Brokers should view their role "as providing a platform to enable the evolution of an ongoing goodwill-relationship" (Davenport et al., 1999; 38). Their study suggests a *stage-based instrument* with a portfolio of mechanisms with increasing financial support as the interaction progresses:

> "A primary level scheme might facilitate the initial contact between prospective partners in order to develop competence trust through familiarity. A next stage scheme could support smaller 'testing' feasibility projects in which the partners come to respect the cultural differences, to gain collaborative experience and to initiate the development of goodwill trust. The third level would provide for major collaborative research projects." (Davenport et al., 1999; 38).

Furthermore, as the understanding of complexity of the (technology) transfer process, which is described as "the process through which technology moves from outside sources to the organization," the role of innovation agents and policies have evolved (Bessant and Rush, 2000; 155). Bessant and Rush (2000) outline five generations in developing policy role for innovation agents:

1. Passive, linear models; technology transfer happens automatically.
2. Interactive model; technology transfer involves dialogues and exchange between players.
3. Expert consulting to help transfer particular technologies.
4. Expert and process consulting.
5. Learning facilitation.

The fifth generation – *learning facilitation* – recognizes that the key role of intermediaries is to enable firms to learn to do these things by themselves, not merely help the process of transfer, and thereby the "emphasis shifts to mechanisms for facilitating learning within organizations, and uses mechanisms including process consultants and counsellors, [and] learning networks" (Bessant and Rush, 2000; 161).

3.4.4. Innovation roles: boundary spanners and gatekeepers

In the innovation literature, there are several innovation roles of individuals in organizations serving one or more roles in innovation processes, including gatekeeper, scout, idea generator, problem solver, problem owner, champion, project leader, integrator, coach, ambassador, and re-organizer (Boer, 2015). Dodgson (1993) states that within the process of collaboration and innovation, the role of key individuals is well known, including gatekeepers and boundary spanners (Allen, 1977; Tushman, 1977), which refers to individuals whose relationship spans boundaries, within and beyond the firm (Conway and Steward, 2009).

The important role of 'gatekeepers' is to search for new knowledge and technology, and disseminate the useful information within the firm, and thus are externally oriented and specialized in external domains (Allen, 1997; Tushman, 1977). Moreover, gatekeepers are *uncertainty absorbers* as they draw inferences from information where ambiguity and uncertainty exists in information received (March and Simon, 1958; Aldrich, 1979). Boundary roles perform two classes of functions, according to Aldrich and Herker (1977), which are *information processing* and *external representation*.

Boundary spanner or gatekeepers are individuals who facilitate communication across functional and organizational boundaries and between activities; providing access to information and innovative ideas from outside the firm, and these roles are crucial for sustaining innovation (Aldrich, 1979; Conway and Steward, 2009). These are 'broker' roles that are associated with individuals who span structural holes (e.g. absence of linkages between two networks or group of people) through their relationships and thus are able to act as intermediaries (Conway and Steward, 2009). As being insiders in the firm, these types of brokers have the role of moving knowledge from another world, for one-time opportunities (Hargadon, 2003).

The boundary spanner's role serves an important function in the innovation process, since boundary-spanning individuals link their work areas to several external information domains (Tushman, 1977). In managing inter-firm links, the role of project managers is important as they generate high levels of trust with external actors; inter-personal relationships built on trust that need to be embedded within a firm's routines and practices, for inter-organizational interaction and trust (Dodgson, 1993).

According to Conway and Steward (2009), 'boundary-spanning' refers to the linkages that transcend the boundaries of a firm, and 'boundary-spanner' refers to individuals who are involved in boundary-spanning activities with knowledge and information flowing to and from the firm. Inter-firm linkages could be established through boundary-spanning activities, or boundary-crossing activities, which are in-between practices that can transform into a boundary practice (Akkerman and Bakker, 2011a).

One may compare boundary practices to the degrees on a continuum moving from individual work to cooperative and collaborative tasks (e.g., Bang and Dalsgaards, 2005). Cooperative processes are tasks divided up and completed individually, and each actor is individually responsible for a particular part of the final product (Henri and Rigault, 1996; Paulus, 2005). In contrast, collaborative work is defined by Roschelle and Teasley (1995) as "a coordinated, synchronous activity that is the results of a continued attempt to construct and maintain a shared conception of a problem" (p.70).

Additionally, Schrage (1990) describes collaboration as a "process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own. Collaboration creates a shared meaning about a process, a product, or event" (p.40).

In the context of the PhD study, the boundary practices at work can be termed as *collaborative boundary practices* that are characterized by coordinated and synchronous boundary-crossing activities in a process of shared creation and shared meaning about a boundary object. Contrary to this is arguably *cooperative boundary practices*, which are characterized by a process with division of tasks to be completed by each actor in boundary-crossing activities.

In the collaborative innovation projects in the GTNV-program, objects are part of these collaborations coordinated and facilitated by brokers. The role of objects in these projects is explored in the empirical research, and therefore the next section addresses the literature on boundary objects, objects-in-use, and design games.

3.5. Objects and design games in collaborative innovation

People and objects can cross boundaries. In this sense, *boundary objects* can be used as intermediaries (Orlikowski, 2002), as they fulfill a *bridging function* (Star and Griesemer, 1989). Intermediaries, such as boundary objects, are of great interest for facilitating knowledge sharing across communities and boundaries (Orlikowski, 2002). "Boundaries can also be crossed by establishing interactions between the actors of different practices" (Akkerman and Bakker, 2011b; 3), such as SMEs and academic researchers. Akkerman and Bakker (2011a) define boundaries as "sociocultural differences leading to discontinuities in action or interaction" (Akkerman and Bakker, 2011a; 133).

People crossing boundaries are often called *brokers, boundary crossers*, and *boundary workers*, whereas objects crossing boundaries are often termed *boundary objects* (Star and Griesemer, 1989; Akkerman and Bakker, 2011a, 2011b). In knowledge sharing, boundary crossing and knowledge sharing, the concept of boundary object has been used in research (Lindberg and Walter, 2013). Sapsed and Salter (2004) state that boundary objects "provide a basis for negotiation and knowledge exchange between differentiated communities of practice" (p. 1515). Objects have the potential of *transforming* knowledge, and some objects are more effective than others (Carlile, 2002). According to Carlile (2002), "knowledge is both a source of and a barrier to innovation" (p. 442).

Boundary objects are artifacts that address multiple perspectives and articulate meaning of different actors (Akkerman and Bakker, 2011a), and act as 'bridge-building devices' (Lindegaard, 2014). Moreover, boundary crossing requires ways of speaking that are understood by different actors, which occurs through the use and development of boundary objects, where a common purpose operates under the assumption that there is value in the combination of the actors' knowledge bases (Halpern, 2011).

In cross-disciplinary or multidisciplinary collaboration, *knowledge creation* can be the main focus. Fong (2013) develops a conceptual model of the knowledge creation process. In the empirical study by Fong (2013) on multidisciplinary project teams in two development projects, five processes are proposed for knowledge creation. The pre-requisite boundary crossing is followed by three processes, which include *knowledge sharing, knowledge generation,* and *knowledge integration*. Central to the three non-linear knowledge processes are collective project learning (Fong, 2013).

In Carlile's (2002) ethnographic study on knowledge boundaries and its structure within four functions, he builds on the work of Grant (1996) on knowledge integration, Teece et al. (1997) on creating knowledge, and the notion of competitive success over time is created with knowledge as a critical factor (Kogut and Zander 1992, Nonaka and Takeuchi 1995). Carlile develops a 'pragmatic view of knowledge' and boundaries, and his study in new product development helps to explain "the role

that boundary objects play in establishing an infrastructure or process where knowledge can be represented, learned, and transformed" (2002; 454).

3.5.1. Types of objects

Things, artefacts, and objects and their role in different contexts can be classified into different categorizations. Star (2010) claims that, "An object is something people act toward and with. Its materiality derives from action, not from the sense of prefabricated stuff or 'thing'-ness" (2010; p. 603). Objects are not stable entities, objects are enacted into being (Law and Singleton, 2005; Lindberg and Walter, 2013), and therefore termed as *objects-in-use* (Lindberg and Walter, 2013). Star and Griesemer (1989) introduced and defined the term 'boundary objects':

> "Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds." (Star and Griesemer, 1989; 393).

Boundary objects help the actions of different groups to connect (Lindberg and Walter, 2013). Lindberg and Walter (2013) address the role of objects in processes of organizing, where objects are seen as material arrangements. Carlile (2002) addresses what objects are effective in which contexts, i.e. *semantic, syntactic*, and *pragmatic*. Carlile (2002) describes, "A pragmatic approach to boundaries assumes the conditions of difference, dependence and novelty are all present, and so recognizes the requirement of an overall process for transforming existing knowledge to deal with the negative consequences that arise" (p. 445).

In Sapsed and Salter's (2004) study on global or dispersed programs of teamwork, they argue that project management tools, as *web-based communication devices* are *ineffective* as boundary objects, since "the lack of opportunity for face-to-face meeting was a major factor in the 'lapsing' of the program management tools as boundary objects" (p. 1529). Whereas, Yakura (2002) found that *project timelines*, as "visual means of comparing the actual and planned progress of a project over time" (p. 958) function as 'temporal boundary objects', which allow actors to "negotiate and manage time prospectively and retrospectively" (p. 956). Yakura states, "The narrative quality of temporal boundary objects distinguishes them from

other organizational artifacts and explains some of their unique properties as tools for temporal coordination" (2002; 956).

Nicolini et al. (2012) developed a framework for a pluralist approach on the role of objects in cross-disciplinary collaboration. According to the authors, it can be used to trace the transitional and dynamic status of objects. In their empirical, longitudinal study on day-to-day practice of collaboration among scientists in cross-disciplinary projects, Nicolini et al. (2012) look at objects as *boundary devices, objects of activities, infrastructures,* and *epistemic things*. The authors propose a three-level hierarchy of objects that support the collaboration: *tertiary object, secondary objects,* and *primary objects.*

Tertiary objects are material infrastructures and include rooms, buildings, computers, documents, and the authors argue that without these, collaboration would be impossible. *Secondary objects* – most boundary objects fall into this category – have the function of bridging different boundaries and facilitate collaboration; however, these objects do not motivate the collaboration, nor do they trigger or fuel it. Secondary objects do not explain how boundaries came about, as they do not motivate it; in other words, if no collaboration exists, there are no boundaries (Nicolini et al., 2012). *Primary objects* explain the *why* and *how* of the collaboration, as this type of objects have the capacity to *explain what fuels and motivates* the collaboration; whereas boundary objects, in their framework, explain only the *how* of the collaboration (Nicolini et al., 2012).

A study by Halpern (2011) also addresses the dynamic aspect of objects by distinguishing between *existing, created,* and *appropriated* boundary objects. "Existing boundary objects are artifacts and abstractions brought with participants into the project," (Halpern, 2011; 932), whereas created objects are developed as the actors work together, and appropriated objects "had a specific meaning to one of the participants but was used by that participant for an entirely different reason" (p. 934). In a study on the relational view of the role of objects in coordinating innovation, Scarbrough et al. (2015) "highlights how a system of objects produces coordinative capacity above and beyond the role played by individual objects, or even a plurality of objects" (p.218).

3.5.2. Learning and transformation at boundaries – and through boundary objects

The literature on boundary crossing and boundary object claims *boundaries* to be potential learning resources rather than barriers (Akkerman and Bakker, 2011a). Boundaries are dialogical phenomena with four potential learning mechanisms that can take place at boundaries, including *identification, coordination, reflection,* and *transformation* (Akkerman and Bakker, 2011a). Unlike the former three learning mechanisms, "transformation can entail the emergence of new in-between practices" (p. 150). Along those lines, transformation as a learning mechanism could

entail objects to help the process of knowledge transformation, in which learning is embedded.

Carlile points out, “The cross-boundary challenge is not just that communication is hard, but that to resolve the negative consequences by the individuals from each function they have to be willing to alter their own knowledge, but also be capable of influencing or transforming the knowledge used by the other function” (2002; 445). Carlile (2002) refers to the *process of transforming knowledge* as a “process of altering current knowledge creating new knowledge, and validating it within each function and collectively across functions” (p. 445), where “individuals represent, learn, negotiate, and alter the current knowledge and create new knowledge to resolve the consequences identified” (p. 453).

Furthermore, Carlile develops a framework that describes three progressively complex boundaries of syntactic, semantic, and pragmatic, as well as three progressively complex processes of *transfer, translation,* and *transformation* (2002, 2004). According to Carlile (2002, 2004), the following capabilities and objects are needed at the various knowledge boundaries. At the *syntactic knowledge boundary*, knowledge transfer capabilities are needed, and the integrating devices are ‘processing’ tools, such as repositories, e.g. CAD/CAM databases, cost databases, with a common reference point. At the *semantic knowledge boundary*, the capability of knowledge translation is needed, and includes integrating devices of standardized forms and methods, e.g. standards for reporting findings, with a mutually understood structure and language. Finally, at the *pragmatic knowledge boundary*, capabilities for knowledge transformation are needed, as novelty increases from syntactic to semantic to pragmatic boundaries. The objects that support knowledge transformation are artifacts, e.g. drawings, sketches, computer simulations, process maps, Gantt charts, which are “simple or complex representations that can be observed and then used across different functional settings” (Carlile, 2002; 451).

The four characteristics of a process to share and assess knowledge describe the capability required at a pragmatic boundary (Carlile, 2004; pp. 562-563):

1. The development of a common lexicon that actors use as they share and assess each other’s knowledge.
2. The ability to identify and learn about new differences and dependencies between them when novelty is present.
3. Transforming the actors’ domain-specific knowledge in order for them to work effectively together.
4. Multiple iterations are required for managing knowledge at a pragmatic boundary.

As Carlile (2004; 656) pinpoints, “The distinction between types of boundaries reminds us that depending on the type of boundary faced, boundary objects with different capacities are required.” The framework developed by Carlile (2004)

explains “why a given boundary object is no ‘magic bullet’ (Carlile, 2002) when it is used in a situation where its capacity as a type of common knowledge (lexicon, meaning, interests) and/or the ability of the actors to use it is not well matched” (p. 656). Carlile (2004) connects his study to *dynamic capabilities*, “Applying this framework to strategic questions provides a concrete way to describe core concepts such as dynamic capability (Teece et al. 1997), where the stated concern has been how to change old knowledge to create new knowledge in a firm” (p. 566). Thus, Carlile views the firm as a “bundle of different types of boundaries where knowledge must be shared and assessed” (2004; 566).

Zeiss and Groenewegen (2009) present the differences of boundary objects in the Organization and Management Studies (OMS) and Science and Technology Studies (STS) in an extensive literature review. Boundary objects are *context dependent* in both OMS and STS. In OMS, there is “a general sense that particular objects have (inherent) features that make them (more or less effective) boundary objects” (Zeiss and Groenewegen, 2009; 92). Whereas, “many STS scholars only regard objects as boundary objects if they are ‘successful’ in being boundary objects” and thus only becomes a boundary object “if it works like one and not because of its intrinsic properties” (Zeiss and Groenewegen, 2009; 93). In sum, the boundary object is construed as *management tools* as in OMS “the emphasis is more functionalist, instrumental and prescriptive” (p.94). In view of objects, new objects need to be introduced to a collaboration in order to fuel it and ensure that it does not lose momentum (Nicolini et al., 2012).

According to Nicolini et al. (2012), managers need to be aware of and expect that different objects will be perceived and understood differently by different actors in collaborative work. The authors pinpoint two critical factors that can make the difference between a successful and unsuccessful cross-disciplinary work; managers must *probe* the different understandings and *manage* the conflicts and tensions that emerge in the collaboration (Nicolini et al., 2012).

3.5.3. Design games: as research methods and reflective tools

Design games and the game pieces function as boundary objects for initiating and facilitating collaboration (Brandt and Messeter, 2004). In co-design and co-creation processes, design games can be viewed as a *tool*, as a *mindset*, and as a *structure* (Vaajakallio and Mattelmäki, 2014). For ‘design game designers’ and facilitators of such process, design games offer structures to engage multiple stakeholders to negotiate, generate, and express shared understandings of contexts and users (Vaajakallio and Mattelmäki, 2014). As tools, design games exploring ‘as-is-worlds’ and ‘as-if-worlds’ engage participants in designing existing practices or practices of the futures (Brandt et al., 2008), as well as facilitating collaboration (Brandt and Messeter, 2004).

According to Brandt et al. (2008), *board games* and *exploratory design games* have the quality of formatting design dialogues. Brandt (2006) states that authors in participatory design underscores "designing the process itself is just as important as designing the artefact" (p.57). Creating a platform with tangible and visual components help the participants share their focus of attention to engage in a dialogue, and thereby the materials in design games aim to support *making, telling* and *enacting* (Vaajakallio and Mattelmäki, 2014).

Processes undertaken in exploratory design games are *games with rules and tangible pieces*, where participants collaborate to complement each other's competences and skills (Brandt, 2006). All in all, exploratory design games are about creating common understandings of the development task at hand (Brandt and Messeter, 2004) and enables the participants to grasp a conceptual totality as they have a bird's eye vantage point (Johansson et al., 2002). Essentially, "thinking with the hand is a way to reach a richer learning experience" (Gudiksen et al., 2014; 17) is the underlying concept in design games, as these provide the opportunity for mutual learning (Brandt et al., 2008).

Furthermore, in *participatory innovation* (Buur and Matthews, 2008), the core assumption is that different stakeholders or actors contribute to innovation (Buur et al, 2013). Actors from different 'social worlds' engage in an 'arena of in-between' (Strauss, 1978). An example of such is firms collaborating with academic researchers, as these actors come from the business world and the world of academia. Exploratory design games as tools lead to the thought that objects of such have the potential to transform knowledge (e.g. Carlile, 2002, 2004) between two worlds through real dialogue between 'flesh-and-blood partners' (Engeström et al., 1995).

In a related literature to design games, *gamification* as a term has been used for many contexts that have been 'gamified'. The term 'gamification' originates in the digital media industry with the first documented use in 2008 and widespread adoption second half of 2010, and the term has "managed to institutionalize itself as the common household term" (Deterding et. al. 2011; 9) – although there is no clear definition of 'gamification' in the literature.

Design games fall in the category of *serious games*; those are 'full-fledged games' used for serious purposes in non-game contexts (Deterding et al., 2011). The authors propose a definition of *gamification* as "the use of game design elements in non-game contexts" and suggest not delimiting the term to specific usage contexts, purposes, or scenarios (Deterding et al., 2011; 9). Although this definition is broad, their illustration on situating gamification in the larger field – gamification as a 'gameful design' – which fall in the realm of 'using games', however in a parallel category to design games. Thus, according to Deterding et al. (2011), design games are not 'gamification'; this is perhaps the case, as they do not want to delimit the term to specific purposes and contexts. On the other hand, Huotari and Hamari (2012) define gamification from a service-marketing perspective as "a process of

enhancing a service with affordances for gameful experiences in order to support user's overall value creation" (p. 19).

In processes undertaken with tangible games, unlike virtual games, the definitions arguably go along the concepts of those within the design game literature. These include formatting dialogues for mutual learning (Brandt et al, 2008) in a platform where shared focus of attention of a specific task (Vaajakallio and Mattelmäki, 2014), where thinking with the hands (Gudiksen, 2015) with tangible and visual game pieces (Brandt, 2006; Gudiksen et al., 2014; Vaajakallio and Mattelmäki, 2014). Design games are essentially tangible game design elements in non-game contexts. The process of, for instance exploring existing or future practices (Brandt et al., 2008), supports the participants' overall value creation through the use of tangible pieces that enhances a particular service, e.g. exploring existing or future practice, with affordances for gameful experiences for a common understanding of the contexts or issues at hand.

Nonetheless, in a literature review of empirical studies on gamification, Hamari et al. (2014) point out that "gamification provides positive effects, however, the effects are greatly dependent on the context in which the gamification is being implemented, as well as on the users using it" (p. 3025). The authors claim that "user qualities were believed to have an effect on attitudes towards gamification… thus explaining why in certain environments or only with certain users, gamification had significant effects… and people in fact interact with game-like systems in different manners, and for different reasons" (p. 3030). This is most likely to be true for design games as well, as the context in question and actor qualities of participants, involved in exploratory design games and participatory innovation (e.g. Brandt, 2006; Brandt et al., 2008; Buur and Mathews, 2008), will arguably influence the effects of these types of tools.

Examples of design games and participatory design include 'The User Game' (Brandt and Messeter, 2004; Brandt, 2006; Brandt et al., 2008), 'The Landscape Game' (Brandt and Messeter, 2004; Brandt, 2006; Brand et al. 2008), 'The Technology Game' (Brandt and Messeter, 2004), and 'The Scenario Game' (Brandt and Messeter, 2004). Moreover, examples of using tangible game elements in non-game contexts, in for instance in making business models, 'Distribution Sandplay' (Gudiksen et al, 2014), 'Partnerships' (Gudiksen et al, 2014; Gudiksen, 2015), 'Pinball Flow Game' (Gudiksen et al., 2014), 'Business Model Butterfly' (Buur et al., 2013), 'Market Dominance' (Gudiksen, 2015), 'Revenue Stream Loop' (Gudiksen, 2015), 'The Silver Set' combined with Osterwalder's business model canvas (Buur and Mitchell, 2011), and within strategy, 'LEGO® Serious Play®' (Gudiksen, 2015).

The next section concludes the literature review by aligning the theoretical to the empirical lens, and thus outlines the positioning of the PhD project. This is illustrated in the *figure 3.1* and shapes the foundation for *collaborative boundary practices*, which are discussed in the conclusions (*Part IV*).

3.6. Positioning the PhD project

The empirical lens – the GTNV-program and its model – connects the various bodies of literature. Innovation management and knowledge management, and concepts within university-industry collaboration, dynamic capabilities, knowledge brokers and brokering activities, objects and design games, are all linked in the GTNV-program and its model, and therefore makes the regional program a very interesting empirical lens for explaining and thereby understanding how SMEs collaborate with Academia. Describing the process of collaboration with these concepts, we gain an understanding of what happens empirically and conceptually. Through this exploration, new insights and concepts are developed to better describe the types of brokers, types of knowledge flows, types of microfoundations built, and types of objects used in these empirical settings. Developing the exploratory design game – *Object Game* – brings about collaborative reflection as a research tool, a reflective tool, and a boundary object, in order to understand the context, process and objects used in the collaborative innovation projects coordinated and facilitated by brokers in the GTNV-program. We therefore look at innovation processes and dynamic capabilities core concepts combined with objects and design games to provide a theoretical lens to explore how SMEs collaborate with Academia.

Innovation is a complex and interactive process, and working with many different actors is what makes innovation happen (Bessant and Tidd, 2007). Akkerman and Bakker (2011b) argue that spaces where actors from different boundaries interact are an opportunity for learning. It is an 'unfamiliar domain' (Engestrøm et al., 1995) for the SMEs in the multiple case studies of this PhD project, especially as it is the first time they collaborate with academic researchers. Managing links between organizations and making knowledge *flow* in order to combine and deploy knowledge to make innovation happen – and to effectuate strategic change in firms – is thus complex processes of interactions between various actors with different backgrounds, where information and knowledge will flow between actors in collaborations (Bessant and Tidd, 2007). These 'knowledge flows' are to certain extent supported and facilitated by brokers and objects.

The collaborative innovation process is a type of open innovation (Chesbrough, 2006) as the firm incorporate ideas and knowledge from academia through projects. Projects are formal knowledge integration mechanism between different knowledge boundaries (Bengtsson et al., 2015). The projects and their innovation processes are in-between boundaries, at a pragmatic knowledge boundary (Carlile, 2004) where the actors use (potential) boundary objects to transform knowledge, which then can be integrated into the firm (Star and Griesemer, 1989; Grant, 1996; Carlile, 2002). This all occurs through knowledge brokering activities through the GTNV-program, which essentially is (re)combining existing knowledge bases to create new context- and situation-specific knowledge for collaborative innovation – and recombinant innovation (Hargadon, 2003).

Hence, objects and boundary objects inevitably play a role in these processes, and the empirical research sets out to explore the role of objects in collaborative innovation projects. Understanding the role of objects in collaborative innovation projects is therefore essential to being able to transform knowledge – for innovative or improved outputs. The act of opening up and applying a new mechanism of boundary activities with external actors is an organizational innovation.

Firms need to have the ability to absorb knowledge, i.e. absorptive capacity (Cohen and Levinthal, 1990), in order to integrate external knowledge from external sources. From a capabilities view, to apply knowledge as a resource into the firm's resource base, the firm and its managers needs to have the capacity to adapt to change and to make changes, i.e. dynamic managerial capabilities and relational capabilities (Teece et al., 1997; Teece, 2007; Helfat et al., 2007).

Through these collaborative innovation projects, practical and academic knowledge bases are combined to generate (new) context- and situation-specific knowledge to be absorbed and integrated into the firm's resource base. The act of integrating the new knowledge generated into operational activities is an act of exploiting the output of a collaboration. Most SME's have certain limitations, including limited resources such as financial, people and time – survival is of the essence. Therefore, untapped resources at universities can be explored and exploited by firms, and brokers and objects play a role in facilitating knowledge flows between actors with different knowledge bases.

The empirical research is exploring the 'in-between practices' or 'boundary practices' where the underlying learning mechanism is transformation (Akkerman and Bakker, 2011a) through the means of face-to-face interaction, real dialogue between 'flesh-and-blood partners' (Engeström et al., 1995), and using various types of objects. In boundary practices, the firm also needs to have the ability to interact with, as well as to have the capacity to include resources, from external actors, and these are relational capabilities (Helfat et al., 2007). The boundary practices include the elements of collaborative innovation projects are in this context termed *collaborative boundary practices*, which are characterized by coordinated and synchronous boundary-crossing activities in a process of shared creation and shared meaning about a boundary object.

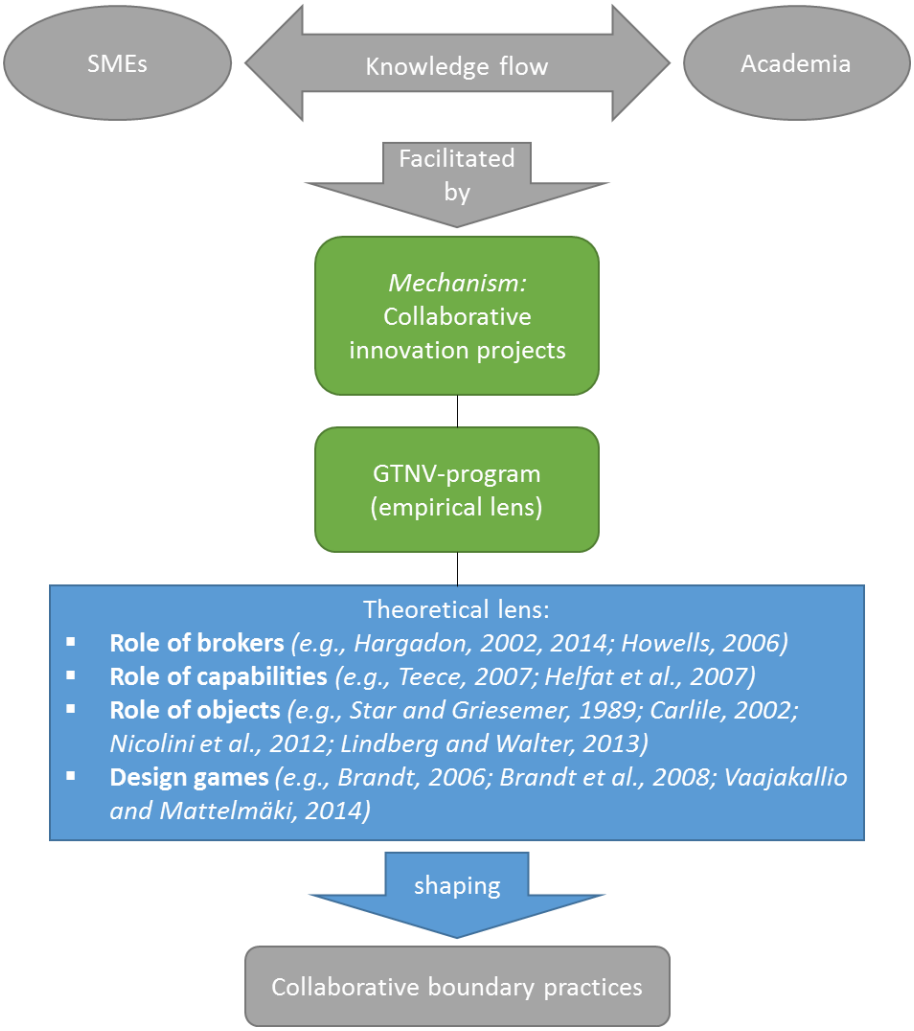
In theory, engaging in collaborative innovation projects can assist building and strengthening these different capabilities in SMEs and their abilities to effectuate strategic change for long-term survival. However, dynamic capabilities are very difficult to observe empirically and therefore part of the empirical research is a conceptual discussions linking and aligning the dynamic capabilities framework (Teece, 2007) to concepts in innovation and knowledge management (e.g., Nonaka, 1994; Grant, 1996; Hargadon, 2003; Tranfield et. al, 2006; Bessant and Tidd, 2007).

To make collaborative innovation projects more 'hands on', the concept of exploratory design games comes into play (e.g., Brandt, 2006). A design game is

developed for the specific purposes of identifying the role of objects in these projects, and how these objects facilitate different types of knowledge flows – *transfer, exchange, generation,* and *integration* – as introduced in *section 3.1.2*. The design game – *Object Game* – is in itself a boundary object that engages the collaborators in a dialogue to reflect on how different objects have facilitated knowledge flows between their knowledge bases. Through the co-design workshop in the empirical research, the role of objects in collaborative innovation projects become more evident.

Understanding of the role of brokers and objects, how these facilitate knowledge flows, and identifying the elements of collaborative innovation projects that shape collaborative boundary practices, combined with the different capabilities that are built and applied in these processes, are essential to understanding how SMEs collaborate with Academia – and why it is important. The interconnectedness of the areas of brokers, capabilities, objects, and design games is illustrated in *figure 3.1.,* where all areas are needed in order to describe and explain how knowledge flow between SME and Academia occurs as facilitated by the mechanism of collaborative innovation projects in the GTNV-program – and shape a (new) collaborative boundary practice.

Figure 3.1. Positioning the PhD Project: Linking the empirical and theoretical lenses.



How do SMEs collaborate with Academia? is studied through the empirical lens in order to answer the central question by exploring the processes through the theoretical lens built on concepts within the fields of innovation management, strategic management, and knowledge management. Therefore, the research questions (previously introduced in *chapter 1*) are primarily based on empirical curiosity complemented by theoretical concepts. The three areas of focus – brokers, capabilities, objects – narrow the scope to study how the processes occur in the mechanism of collaborative innovation projects.

The first sub-question is inspired by research within university-industry collaboration, as those are the two main actors, and by research within strategic management, e.g. dynamic capabilities, as the aim of these collaborations is growth within the firms, and thus growth through effectuating change that may lead to innovation. It is all about figuring out, how do SMEs and academic researchers combine their different (existing) knowledge bases through processes that make collaborative innovation happen, and the following sub-question is formulated:

How does collaborative innovation take place between SMEs and Academia, and how do they combine their knowledge bases?

The second sub-question focuses on the role of brokers, as the empirical lens has different type of external actors that coordinate and facilitate interaction between SMEs and Academia. The question is based on the literature within innovation management where brokers play a role in innovation processes. The empirical research investigates these brokers in the GTNV-program in order to gain an understanding on their roles in collaborative innovation projects, and this formulates the following second sub-question:

What is the role of brokers in collaborative innovation projects?

The third sub-question addresses the role of objects in facilitating knowledge flow between SMEs and academic researchers. Objects in collaborative innovation projects are identified and tested in the empirical research, and based on research on objects used by different actors, the third sub-question is formulated as:

What types of objects facilitate the knowledge sharing process – and how?

The three sub-questions underscore different aspects of collaborative innovation projects as coordinated and facilitated in practice. Research guided by these questions aids our understanding on how collaboration between SMEs and Academia can take place – and this will inform and shape a definition of collaborative boundary practice that can be perceived as more general and thus be transferred to contexts where firms collaborate with external actors.

Bridge to *PART III. EMPIRICAL RESEARCH*

The literature review builds the foundation for the empirical research conducted in the subsequent part of the PhD dissertation. *Chapters 4, 5, 6,* and *7* explore the mechanism of collaborative innovation projects with the theoretical lens developed in this chapter to discover how SMEs collaborate with Academia through the empirical lens – GTNV-program – and to answer the sub-questions.

Chapter 4 investigates the elements of collaborative innovation projects and explores the role of brokers. *Chapter 5* is a further development of the GTNV-model presented in chapter 1 and a conceptual discussion on how SMEs can build microfoundations of dynamic capabilities by collaborating with external knowledge actors. *Chapter 6* presents the development and design of the exploratory design game, the Object Game, and shows how it facilitates dialogue through interaction with the game materials. *Chapter 7* identifies and defines the objects in collaborative innovation projects, and explores how these objects facilitate knowledge flows between SMEs and Academia.

The findings in the empirical research lay the grounds for a (new) definition of collaborative boundary practices, which are discussed in *Part IV. How do SMEs collaborate with Academia?*.

The following article in *chapter 4* is published in the *Danish Journal of Management & Business, nr. 1, 2016,* with the same title as in this chapter: *Interaction enablers, drivers and barriers of collaborative innovation projects between small firms and academia.* As the title indicates, elements of the collaborative innovation projects are identified and categorized, including 'interaction enablers', 'drivers' and 'barriers', as found in five case studies. The role of brokers is explored, and we find that there are different types of brokers – at meta-level and micro-level – and it is important to distinguish between those. The findings from the study as presented in *chapter 4* are also addressed in a conceptual discussion in *chapter 5*, which builds on the GTNV-model presented in *Part I.*

PART III.

EMPIRICAL RESEARCH

Chapter 4.

Interaction enablers, drivers and barriers of collaborative innovation projects between small firms and academia[24]

Diane Filip, Bettina Dencker Hansen,
and Thea Thorsgaard Frølunde

Abstract

Collaborative innovation projects are boundary-crossing activities in which knowledge bases from practice and academia are combined for innovations in small firms. In this study, small firms gain access to academic knowledge resources through a structured and formalized regional program. From a process-perspective, we explore five case studies and identify elements of collaborative innovation projects between small firms, academic researchers, and independent third parties in a Danish regional program. The elements are categorized into *interaction enablers*, *collaboration characteristics*, *main drivers*, and *main barriers*. Our three major findings relate to the phases of a structured program, elements of collaborative innovation projects, and the facilitation of interaction at two levels, i.e. *meta-level* and *micro-level*, by two types of brokers. The operator of the regional program facilitates the process at a meta-level and acts as a knowledge broker (e.g., Hargadon, 2003, 2014). The third party facilitates the process first hand and at a micro-level. We term this type of broker, a *broker of human interaction*, who ensures face-to-face interaction between the two primary actors, i.e. small firm and academic researcher(s). We find that the broker of human interaction supports the development of relational capabilities, i.e. the small firm's capacity to purposefully create, extend, or modify its resource base by including the (knowledge) resources of external actors (e.g., Helfat et al., 2007). The two types of brokers acting at two different levels have proven to be useful in overcoming some of the classical barriers firms face when interacting with academia. Essentially, the gap between the world of business and the world of academia has been mitigated by the structured and formalized interactions facilitated by brokers at both *meta-level* and *micro-level*. This study has practical implication for managers, as they can be guided by the elements of collaborative innovation projects and shift their mindset towards

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collaborating with different types of partners in a pursuit to recognize and shape opportunities with academia.

Keywords: Collaborative innovation projects, Collaboration, Small firms, Academic researchers, Brokers, Knowledge base

1. Introduction

One of the core skills that firms need is the ability to integrate and combine intangible assets such as knowledge (Kogut and Zander, 1992; Grant, 1996; Teece, 2007). Knowledge is the predominant resource of the firm (Grant, 1996a), however knowledge integration are complex and team-based productive activities, which depend on "the firm's ability to harness and integrate the knowledge of many individual specialists" (Grant, 1996b; 116), within and outside the firm. New knowledge outside the firm is a source of innovation (Drucker, 1985) and collaboration is part of innovation (Dodgson, 2014). Bridging the social worlds (Strauss, 1978) and thought worlds (Dougherty, 1992) through collaboration, such as collaborative innovation projects, is an act of exploring and exploiting the strength of weak ties (Granovetter, 1973) in the context of interactions between small and medium-sized enterprises (SMEs) and academic researchers.

A firm's ability to create and sustain competitive advantage is essentially anchored in the processes through which the firm integrates specialized knowledge (Grant, 1996b), and these include a firms collaboration with universities, such as through collaborative innovation projects. In these interactions between firm and academia, knowledge brokering occurs, which is a process where knowledge is moved from one knowledge base to another (e.g., Hargadon, 2003, 2014). This "exchange" between knowledge bases may lead to existing knowledge being combined in new ways; a recombination of existing knowledge embedded in ideas, artefact and people (e.g., Hargadon, 2014).

The aim of this study is to identify the drivers and barriers of collaborative projects between small firms, academic researchers, and brokers (third parties) in a regional program in Denmark. The purpose of these projects is that the actors collaboratively generate context- and situation-specific knowledge that may lead to innovation. Innovation is the act of inventing, developing, and implementing ideas (Garud et al., 2013), therefore innovation is inherently a process, or a set of activities. Innovation can be a process as well as an outcome (e.g. Garud et al., 2013). Innovation processes can be analyzed as a whole by acknowledging the dynamic interaction between the three levels of innovation: institutional, organizational and small group (Hargadon, 2014). Collaborative innovation is shaped by the interactions across levels, boundaries, and time. We study the interactions between the different actors from a process-perspective in order to identify the drivers and barriers in collaborative innovation projects.

Research indicates that firms benefit from collaborating with knowledge institutions, including universities and research institutes (Etzkowitz and Leydesdorff, 2000; Turpin et al., 1996). Firms collaborating with universities generate sales of innovative products and services novel to the market, and thereby improving their growth performance (Belderbos et al., 2004). These findings are the outcomes of collaborations. This study focuses on the process rather than the outcome of projects. The questions in this study are: How does a firm collaborate with academic researchers? What are the elements that drives the collaboration and what are the barriers? What characterizes this type of collaboration? What are the elements that enable interaction between the different actors, i.e. "interaction enablers"?

The regional program presented and studied is an example of how the process of collaboration between a firm and academic researcher can be coordinated at a meta-level by "knowledge brokers" (Hargadon, 2003) and facilitated at a micro-level by brokers, whom we call *brokers of human interaction*. The process of collaborative projects is studied in order to gain an understanding of the elements that enable interaction, as well as the drivers and barriers of the collaboration.

2. Literature review

Academics have addressed the various barriers that constitute a *gap* – or distance – between the business world and academic world. This so-called gap is primarily rooted in differences, including language, time horizon, culture, expectations, daily activities, communication styles (Davenport et al., 1999; Iles and Yolles, 2002; Perkmann and Salter, 2012; Tartari et al., 2012). There are also great differences in the world of business – between small and medium-sized firms and large firms. For instance, most large firms have sufficient resources to invest in activities that generate innovations (i.e. R&D, market exploration, and finance collection), whereas many SMEs lack human and financial resources to devote to innovative efforts and practices (Parrilli et al., 2010). SMEs have a stronger need to collaborate because of their lack of internal resources and limited resources for basic research (Katzy et al. 2013). In addition, SMEs innovate differently than large firms, and SMEs generally face more uncertainties and barriers to innovation (Roxas et al., 2011).

Interactions between business and academia have the potential to assist the role of SMEs as important actors in creating, applying and introducing innovations in local economies (e.g., Curran and Blackburn, 1994). However, SMEs need to overcome (at least) two main barriers, which are the not-invented-here syndrome and lack of absorptive capacity (Bierly and Daly, 2007). Absorptive capacity is "the ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990; 128). Cohen and Levinthal state that the ability to exploit knowledge is a critical component of innovative capabilities (1990).

The concept of absorptive capacity has been expanded on by other authors, including in the direction of learning processes. As a sub-element to building the

firm's capacity, some authors have described the phases of learning processes as exploration, transformation, and exploitation (Lane et al., 2006). Activities related to exploration and exploitation are important to building knowledge (March, 1991), as well as transformation links the exploration and exploitation through internal processes (da Mota Pedrosa et al., 2013). Assuming that knowledge is the fundamental resource in a modern economy, then learning is an essential process (Lundvall, 2010). Learning is embedded in the collaboration process with external actors, therefore knowledge creation between (at least) two actors is bound to be a learning process.

In the world we live in today, "change has become the only constant in industrial life, and uncertainty the only certainty" (Boer, 2004; 2), and with this in mind, dynamic capabilities comes into the theoretical lens. Dynamic capabilities relate to change (Winter, 2003). When collaborating with external partners, relational capabilities come into play and include the capacity to purposefully create, extend, or modify the resource base of the firm by including external resources (Helfat et al., 2007). In this context, the specific resource is knowledge, and the goal is arguably to explore existing knowledge in two knowledge bases – practice and academia – to further exploit existing knowledge for incremental innovations (e.g., Tidd and Bessant, 2013). Projects are means through which existing knowledge outside the knowledge base of the firm can be explored. Projects, as parallel tracks to operational activities, can serve as forums for pursuing new opportunities, since projects are meso-level organizational arrangements (Garud et al., 2013).

Collaborative innovation projects between different actors inherently include boundary-crossing activities. Akkerman and Bakker (2011a) describe a boundary as a sociocultural difference leading to discontinuity in action or interaction. Boundary crossing is therefore a term used to indicate a movement across or a co-location of practices (Akkerman, 2011). From an organizational perspective, the movement or co-location leads individuals to enter unfamiliar domains (Engeström et al., 1995). The field where interaction between the individuals from different boundaries or domains takes place can be perceived, in itself, as a 'boundary.'

The unfamiliarity imposes the boundary and may impede understanding and ongoing action; and, boundaries are dynamic constructions, as well as very personal and locally encountered by individuals (Akkerman, 2011). As argued by Akkerman and Bakker (2011b), the underlying idea in the literature on boundaries is that boundaries can be barriers to learning, but at the same time function as spaces with potential for learning something new and significantly different from that which is known and common (Akkerman, 2011).

When the underlying mechanism in boundary crossing is transformation, then "boundary crossing leads to changes in practices or even the creation of a new in-between practice, for example a boundary practice" (Akkerman and Bakker, 2011b; 3). Additionally, transformation involves "real dialogue and collaboration between

'flesh-and-blood partners' at either side of the boundary" (Engeström et al., 1995; 333). As Akkerman and Bakker (2011a) state:

"Dialogical engagement at the boundary does not mean a fusion of the intersecting social worlds or a dissolving of the boundary. Hence, boundary crossing should not be seen as a process of moving from initial diversity and multiplicity to homogeneity and unity but rather as a process of establishing continuity in a situation of sociocultural difference. This holds also for the transformation mechanism, in which something new is generated in the interchange of the existing practices, precisely by virtue of their differences. This leaves open whether these practices, over time, develop a new core practice." (Akkerman and Bakker, 2011a; 152)

In boundary-crossing activities between small firms and academic researchers, when know-how is successfully integrated into the firm, then learning occurs (e.g., Teece, 2007). Furthermore, people between and crossing boundaries are often called brokers or intermediaries. The term intermediary has been examined in different contexts; roles and functions of the intermediaries have been identified as performing a variety of tasks within the innovation process (Howells, 2006). For instance, the main function of a consultancy service is helping "bridge the gap between technological opportunity and user needs" (Bessant and Rush, 1995; 101). The innovation intermediaries may function as a broker, whose aim is to achieve a transaction (Chesbrough, 2006), or may function as a communication entity between stakeholders in the innovation system (Katzy et al. 2013; Howells, 2006). Knowledge brokers are agencies or individuals which main function is brokering knowledge (Hargadon, 2003, 2014).

The outset of this study is the gap between two worlds. The regional program presented in the following section is an example of a structured process facilitating interactions between the world of business and academia, where an independent third party is supporting the process of collaborative innovation projects. We study the process and interactions as boundary-crossing activities that form a boundary practice. In order for the firm to integrate the knowledge generated in the collaboration, the firms must have the ability to absorb the knowledge, learn, and apply it in operational activities. In other words, explore, transform, and exploit the knowledge generated in the boundary-crossing activities with academic researchers.

We study this boundary practice as structured through the regional program, and we analyze it through the dynamic capabilities framework, e.g. the underlying processes through which the small firms undergo. Dynamic capabilities can for analytical purposes be disaggregated into sensing, seizing, and transformation capabilities (Teece, 2007), although reality is more complex. We apply Helfat et al.'s definition of dynamic capabilities, "the capacity of an organization to purposefully create, extend, or modify its resource base" (2007; 4), and we identify the elements of collaborative innovation projects in five case studies. The aim is to gain an understanding of how firms collaborate with academic researchers, and how this boundary practice is shaped by the brokers facilitating interaction through the

regional program. We do so by identifying the interaction enablers, drivers and barriers to this type of collaboration and by describing the role of the two types of brokers acting at different levels, especially the broker of human interaction's role in supporting relational capability building in firms.

3. Empirical research: Case studies in a Danish regional program

In 2011, the Central Region of Denmark initiated a 3-year regional program called *Genvej til Ny Viden* (GTNV-program), in English, *Shortcut to New Knowledge*. The overall aim of this regional program is to create growth in SMEs through generating (new) knowledge in collaborative innovation projects between SMEs and academic researchers, and by allocating an independent third party to facilitate the process and ensure interaction. All firms in the GTNV-program have very limited or no experience collaborating with academia.

Transfer of technology or knowledge is not the objective of the GTNV-program; the focus is on generating knowledge that is new and specific to the firm. This type of collaboration generates new knowledge to the firm based on the published knowledge by the academic researcher. The goal is to recombine academic and practical knowledge to generate new knowledge. Since both parties contribute to the creation of new context- and situation-specific knowledge, these projects are not about developing basic research and new publications, but about applying *known* (i.e., existing and published) knowledge into new contexts.

The GTNV-program has structured the collaborative innovation projects into three phases – initial, preliminary, and main. This is illustrated in *figure 1*. In a 3-year period, 52 SMEs completed the preliminary phase with a remaining 34 SMEs receiving funding for the main phase. In total, 31 SMEs completed all phases. The duration of projects ranged from two to three years. Five collaborative innovation projects constitute the empirical data in this study, and to be noted is the size of the firms: 15 employees or less, therefore small firms.

The operator, Centre for Entrepreneurship and Innovation (CEI) at Aarhus University, coordinated all three phases on behalf of the Central Region of Denmark. CEI's main activities during the initial phase is to screen the SMEs that show interest in the program, identify their needs, and meet face-to-face with the firms. As illustrated in *figure 1*, the SME applied in order to enter the preliminary phase, as well as to enter the main phase. For firms to be accepted into the main phase, an expert panel evaluates the applications and the SMEs have to pitch their ideas to the panel. Funding is provided in both the preliminary and main phase – party funded by EU regional funds. The firm invests through hours spent on project-related activities, equivalent to half of the overall budget.

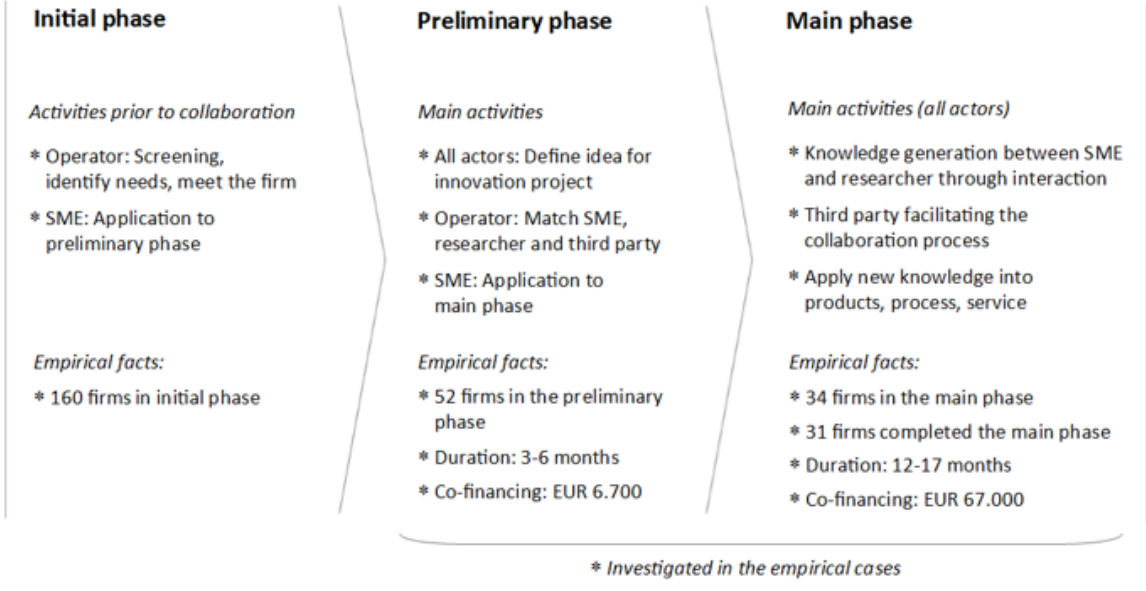


Figure 1. The GTNV-program for collaborations between SMEs, academic researchers and independent third party.

The operator matches SMEs, which are accepted as eligible firms into the GTNV-program, with academic researchers in the field of expertise. The operator also instructs the independent third party on their intended role as a facilitator ensuring interaction between the actors. Acting as a knowledge broker (e.g., Hargadon, 2003, 2014), CEI not only matches the actors, they also arrange the first meeting between them. The operator has an active role throughout the GTNV-program to facilitate the overall process of collaboration – at a meta-level.

4. Research methods

4.1. Case selection

The method of exploratory case studies was selected to provide the best opportunities in gathering relevant data (Strauss and Corbin, 1990) for a process-perspective on collaborative innovation projects. Five cases, out of 31 that have completed the GTNV-program, were followed over a period of 3 years. All five cases – *Delta, Epsilon, Zeta, Eta, and Theta* – have three things in common:

1. each firm collaborates with (at least) one academic researcher and one independent third party in an innovation project;
2. all are small firms with 15 employees or less; and,
3. CEOs of the small firms are engaged in the collaborative innovation projects.

In addition, the five firms are from various industries. None of the firms are competing in the same nor closely related industries, and the projects have different foci. Three of the innovation projects focus primarily on new product development, whereas the other two focus predominantly on business (and organizational) development.

4.2. Data collection and analysis

Interviews with key informants were the main technique applied for data collection, since interviews are the best source of information when trying to understand the character and motivation for actions taken place in highly embedded social context (Harré and Secord, 1972; Mantere, 2008; Andersen et al., 2013). Interviews are retrospective in nature (Mantere, 2008), and to overcome informant bias, as well as to triangulate data and ensure internal consistency, we interviewed three different types of actors for each innovation project. Through conversation in the interviews, we obtained descriptions of the cases and interpretation (meaning) of this type of collaborative activity (e.g., Kvale and Brinkmann, 2009).

In-depth, semi-structured interviews with each of the actors were conducted in 2011-2014 by following an interview guide in order to reveal how the process between the actors had taken place. *Table 1* gives an overview of the key informants,

number of interviews and duration, type of analysis, and type of data. In total 20 interviews with 19 individuals were conducted. All interviews were recorded and transcribed. Contextual data, in addition to interview data, was collected through documents, such as project applications (e.g. project proposals) and informal correspondence with the actors.

The data from the qualitative interviews was categorized manually in tables (in Excel):

- Who are the primary actors, and who is engaged in the collaboration
- Process of collaboration (description)
- External and internal challenges of the project
- Role and characteristics of SME, Researcher, Broker
- Direct output (i.e., tangible output)
- Indirect output (i.e., output related to the project)
- Understanding of concepts: Innovation, Collaboration
- Motivation
- GTNV-program (positive and negative aspects)
- Duration of the project

Information from documents, such as project applications, were added to the tables. The content for each case with the above categories was re-organized into new tables with more condensed categories into five columns for within-case analysis:

- Interaction enablers
- Collaboration characteristics
- Drivers – with sub-columns of: SME (internal team), Researcher(s), Broker
- Output – sub-columns: direct, indirect
- Challenges – sub-columns: internal, external

To elaborate on some of the above categories, *interaction enablers* refer to elements of the collaborative projects that enhance or make interaction between different actors possible. The *drivers* refer, in short, to elements that make the project progress. *Challenges* relate to obstacles and barriers in the process of collaboration and the project itself; this is from the firm's point of view, and thus *internal* refers to internal challenges to the firm, as well as *external* challenges refer to challenges that lie outside the boundaries of the particular firm.

Table 1. Overview of data sources and type of analysis

Case	Position and *Role* of key informants	# of interviews	# of hours (approx.)	Type of analysis	Type of data
Delta	▪ CEO (owner) ▪ Project Development Coordinator ▪ Associate Professor ▪ Innovation Advisor, *Broker*	4	4.5	▪ Content ▪ Within-case ▪ Cross-case	▪ Interviews ▪ Documents (project applications, public reports)
Epsilon	▪ CEO ▪ Professor ▪ Business Consultant, *Broker*	4	4.5	▪ Content ▪ Within-case ▪ Cross-case	▪ Interviews ▪ Documents (project applications, public reports)
Zeta	▪ CEO (co-owner) ▪ Co-owner ▪ Associate Professor ▪ Researcher ▪ Senior Project Manager, *Broker*	4	5	▪ Content ▪ Within-case ▪ Cross-case	▪ Interviews ▪ Documents (project applications, public reports)
Eta	▪ CEO (owner) ▪ Professor ▪ Consultant, *Broker*	4	4	▪ Content ▪ Within-case ▪ Cross-case	▪ Interviews ▪ Documents (project applications, public reports)
Theta	▪ Business Developer (internal project coordinator) ▪ CEO (owner) ▪ Associate Professor ▪ Head of Innovation, *Broker*	4	4	▪ Content ▪ Within-case ▪ Cross-case	▪ Interview ▪ Documents (project applications, public reports)
Total	*19*	*20*	*22*		

The level of analysis is at project level, as the boundary-crossing activities differ from the firm's operational and daily tasks. For qualitative validity and reliability, we collected data from diverse individuals through interviews and documents (i.e. formal project proposals). In order to overcome potential self-report bias (Maxwell, 2013) the evidence from all five cases was converged to represent same descriptions of the process, and thereby make validity threats regarding the process elements implausible by evidence (Maxwell, 2013). Data in the within-case analysis was examined for reoccurring elements to establish themes based on converging several sources of data in cross-case analysis (Miles and Huberman, 1994; Creswell, 2014; Maxwell, 2013). We then critically discussed the empirical findings in relation to concepts within innovation management, collaborations and dynamic capabilities. Finally, the cross-case analysis resulted in a table with summarized findings of the five collaborative projects, which are presented in *table 2* and elaborated upon in the findings section.

5. Findings: Elements of the collaborative innovation projects

The regional GTNV-program can be perceived as a "package deal" with each firm unpacking it to their specific context and situation. *Table 2* outlines the elements of collaborative innovation projects from the five case studies, and each element is presented and elaborated upon in separate sections.

5.1. Interaction enablers

We find reoccurring elements across the cases that enhance the interaction between the actors and therefore indicate what we call "interaction enablers". We define interaction enablers as aspects or elements that make the collaboration process, and thereby interaction between the actors involved, possible or easier.

From the start, *common and clear goals, rules and structure* are established. *Openness, curiosity, engagement,* and *willingness to learn* are important aspects to create the space for boundary practices between actors from different social worlds. The CEO of *Epsilon* shares their experiences and how they overcame the gap between them and the academic researcher:

> *"We collaborated with an academic researcher on areas of expertise that were non-technology related. We had a very good start with a lot of respect for each other and good chemistry. However, it was not that easy in the beginning, as we often felt like, 'ah, why don't you just understand that it matches to our firm!' Then we realized that we come from two different worlds, but we found some good solutions by simply having to talk more with each other."*

Chemistry and *direct, clear communication* set the grounds for a two-way interaction, including the act of *questioning and listening* to each other. Critical elements facilitating the process are *mutual respect, joy and interest* in the subject matter, as well as *face-to-face interaction*, *honesty,* and *trust*.

5.2. Collaboration characteristics

The characteristics of the collaborations are listed as findings that indicate features and components of the boundary practice. Some of the features are formalized by the GTNV-program, including *alignment of expectations* of all actors, which is facilitated by the operator and independent third parties at kick-off meetings. The formalization of the project is inherently instituted by the GTNV-program, as well as *dialogue* and *interaction* is encouraged for knowledge creation in the boundary-crossing activities. The actors in each project select the means of *interaction* and *communication*. We find that these preferences reflect the context and specific needs of the main actors involved – especially those of the small firm.

5.3. Main drivers

One of the main drivers is the *strategic alignment ('fit')*. The project's objective is closely linked to the firm's existing (and emerging) strategy. Related to this is the leadership's involvement, which is the top manager's (i.e., CEO) active engagement in the innovation process. We find *willingness and openness to change* as drivers of the process, as the small firm is (intuitively) undergoing a transformational process through the collaborative innovation project by integrating knowledge from the innovation project into operational activities.

In projects focusing mainly on new product development, we find that prior knowledge in the firm, including technical knowledge in the area, is a critical driver of the opportunity sensing process. The CEO and co-owner of *Zeta* states:

> *"We had a very clear specification of requirements […] as in what competences we wanted, and the greatest challenges in this project has been to find these. [….] It turned out to be very, very difficult to find the competences we needed. And we spent too much time in the beginning searching before finding the right person, who could solve the task for us. [….] And I honestly believe that we would not have come near the result that we have today with some of the others we had in the beginning."*

This prior knowledge guides the search for external knowledge sources to be captured in the firm's (future) products. Finally, the internal project team is the main driver of anchoring new knowledge into products – and in the rest of the firm.

Table 2. Elements of collaborative innovation projects: enablers, characteristics, drivers, and barriers

Interaction enablers	Collaboration characteristics	Main drivers	Main barriers
Chemistry **Common and clear goals, rules and structure** **Curiosity** **Direct and clear communication** **Engagement** **Face-to-face interaction and conversation** **Mutual respect, joy, and interest** **Openness** **Questioning and listening** **Trust and honesty** **Willingness to learn**	**Phase-based process** Innovation process within a formalized and structured collaborative project (i.e. regional program)	**Strategic alignment ('fit')** Project objective linked to existing strategy of the firm (strategic relevance)	***External*** Challenges for collaborations across organizational borders (project management challenges)
	Early-stage alignment of expectations of all actors involved (at kick-off meeting)	**Leadership involvement** CEO and managers actively engaged in innovation processes	***Internal*** Reallocating resources and people (implementing changes) Acquiring financial resources to leverage new knowledge Risk-aversion in investments to acquire human capital/new competences
	Dialogue-based process Learning and new knowledge creation through face-to-face interaction	**Willingness to change** in relation to process and outcome of innovation project	
	Interaction All-day interactions, workshops, and mutual visitations	**Internal project team** Anchoring new knowledge into operational activities	
	Communication Ongoing communication via e-mail and telephone	**New Product Development (NPD)** Having prior/technical knowledge in the area is key	**Time factor** Allocating time 'slots' for innovation activities

5.4. Main barriers

Individuals involved in the project encounter challenges, and these challenges serve as main barriers for innovative activities. The challenges are not barriers particularly related to a collaboration process between firm and academic researcher. The main challenges identified are *project management related* for actors collaborating across organizational borders. These include coordination, scheduling meeting, and communication across organizational settings, and are not different from other cross-organizational collaborations.

In other words, the gap between the two worlds in these cases is not as wide as some may perceive. There are (at least) two potential reasons for this: the formalized structure of the GTNV-program that guides the actors through the collaboration process, facilitated by the operator at a meta-level; and, the role of the independent third party who ensures interaction between the actors by facilitating the process at micro-level. In this study, we find that the role of a human facilitator of interaction is important in order to overcome challenges at micro-level. We term this role a *broker of human interaction*, as he or she gives a special attention to ensuring open dialogue and face-to-face interaction between the primary actors involved. This we find as an indication for supporting the development of relational capabilities, which Helfat et al. (2007) define as the capacity of the small firm to purposefully create, extend, or modify its resource base by including the resources of external partners. Essentially, the gap has been mitigated by structured and formalized interaction facilitated by brokers at both *meta- and micro-level*.

Moreover, we also identified internal challenges to the small firm. These are barriers that (potentially) impede the ongoing process of collaborative innovation. The main internal challenges faced by the small firms are the *reconfiguration and reallocating of resources and people*. Although the firm is willing and open towards change, implementing change is a different story. *Acquiring extensive financial resources* for marketing and sales functions, in order to leverage the new knowledge generated, is also a challenge faced. Connected to this issue is *risk-aversion in investing in new competences*, such as acquiring human capital to implement change as result of the innovation project. As the CEO and co-owner of *Zeta* states, "We have talked about internationalizing and that we need to hire an international sales person, but we do not dare to take the leap and hire a person, who is likely going to cost over a million [Danish kroner] a year."

The external and internal challenges listed in *table 2* are aggregated across the five projects. Some of the barriers are only identified in certain cases and not necessary present in all five cases. However, the elements outlined indicate barriers in relation to an extensive integration of new knowledge generated and spilled over into operational activities, which are beyond the collaboration and after project termination. Nevertheless, possibly the greatest barrier to innovation activities is the factor of *time*. Managers, researchers, as well as the internal project team, need to reallocate time from operational task to the collaborative innovation project.

Reallocating time is a great challenge, especially in small firms. In general, small firms have a limited time horizon and survival is of the essence. Therefore, allocating time is potentially the greatest barrier to collaborative innovation projects.

5.5. Role of the broker of human interaction

We find that the role of the third party is in practice context-specific, therefore depending on the needs of the firm. In some instances, the role resembles that of a project manager, and in other instances, the third party facilitates the process such that the firm (explicitly) integrates the knowledge created in the innovation process into operational tasks and daily activities. Overall, the third party is what we term a *broker of human interaction*. A broker, who ensures a dialogue-based process, face-to-face interaction and conversation, with a specific purpose. The broker of human interaction primarily assists the small firm with building relational capabilities with a different type of external partner, e.g. academic researcher. The broker encourages reflection on how newly created knowledge may be spilled over into existing operational activities (during the project), as well as underscoring the need for knowledge integration during and after project termination.

6. Discussions

In this study, we explore the process of collaboration between two distant worlds – firms and academia – and identify enablers, drivers and barriers of collaborative projects. The regional program, i.e. the GTNV-program, is an example of how the gap between the world of business and the world of academia can be bridged, or how this distance can be reduced. The gap between the two worlds in these cases is not as wide as some may perceive. There are (at least) two potential reasons for this: the formalized structure of the GTNV-program that guides the actors through the collaboration process, facilitated by the operator at a *meta-level*; and, the role of the independent third party who ensures interaction between the actors by facilitating the process at *micro-level.*

It is important to distinguish between the facilitating role of the operator and the third party. The operator facilitates the interaction between two distant worlds and acts as a knowledge broker (e.g., Hargadon, 2003, 2014). We focus particularly of the role of the third party, and we find that in practice it is context-specific, thus the needs of the firm shape the specific function of the broker. In some instances, the role resembles an administrative function of a project manager or coordinator. In most cases, the role of the third party is to facilitate the process such that the firm (explicitly) integrates the knowledge created in the innovation process into operational tasks and daily activities. The third party is a *broker of human interaction*. Primarily a broker, who ensures a dialogue-based process, face-to-face interaction and conversation – with a specific purpose. This type of broker is present at meetings

and follows the process first hand. Ideally, the third party reports to the operator about the progress of the particular collaborative innovation project.

As we study the collaborative projects as a series of boundary-crossing activities, i.e. boundary practices, we find evidence that the broker of human interaction supports the development of relational capabilities such that the small firm builds the capacity to purposefully create, extend, or modify its resource (knowledge) base by including the resources of external actors. This type of broker, we find, encourages knowledge spillover throughout project duration by asking the small firm (the CEO and project team members) critical questions on how the information and new knowledge created in the collaboration could fit into the firm's existing or new processes, products, and capabilities. Therefore, the broker of human interaction aids the development of dynamic managerial capabilities in the small firm, which are crucial for the firm's ability to effectuate strategic change.

Furthermore, the collaboration process includes boundary-crossing activities in collaborative innovation projects, which constitute (new) boundary practices based on dialogical engagement and transformation (e.g., Akkerman and Bakker, 2011b). These can be termed "collaborative boundary practices" as the aim of the boundary-crossing activities is collaborative work creating something new, by combining existing knowledge from practice and knowledge from academia. In this type of collaborative boundary practice, firms purposefully create new elements in their resource base and thereby integrate resources (i.e., knowledge) from the external source – the academic researcher. Through the collaboration process, new knowledge is created and integrated into the firm.

Allocating time to boundary-crossing activities should not be underestimated by the actors engaging in collaborative projects. Not being able to reallocate time from operational and daily tasks to innovation activities with external actors is potentially the greatest barrier to collaborative innovation. On the other hand, dialogue, face-to-face interaction, and alignment of expectations, we find as essential foundations of collaborative innovation, in addition to trust and respecting each other's differences.

When asking the small firms whether they would want to collaborate with an academic researcher again (the same or a different researcher), all answered either that they are interested or already have initiated steps towards starting new projects with this type of external knowledge actor. Likewise, the academic researchers pinpointed positive aspects of the collaboration, and stated that they were willing to repeat this type of project. We find this as an indication of relationship-building collaboration where trust among the actors is present. Previous research indicates that trust evolves incrementally from repeat relationships between the same partners (Davenport et al., 1999). In the literature on collaborations between universities and industry, several authors underscore the importance of relationships and trust (Davenport et al., 1999; Tartari et al., 2012; Zucker et al., 2002). Arguably, re-occurring collaborations that substantiate relationship- and

trust-building aspects, such as for instance interactions based on face-to-face communication, are important for learning in firms. Additionally, a repeated pattern of this type of boundary practice will, in theory, lead to dynamic (managerial) capabilities and enhanced relational capabilities in small firms.

We also find that prior knowledge in the technical field of a given product is a driver of the process, especially in new product development collaborations. This is a type of absorptive capacity (Cohen and Levinthal, 1990) where the firm follows a path dependent process. In contrast, projects focusing on organizational change and development attempt to discover new pathways and are therefore less path dependent. Overall, the regional GTNV-program provides managers the access to knowledge sources, which is required for opportunity creation and discovery. By undergoing the collaborative process, managers of SMEs develop the ability to search partners outside of their industry and value chain. This is a shift of mindset towards collaborating with different types of partners in an attempt of recognizing and shaping opportunities together with academia.

Nonetheless, this study has some limitation. Interview data is limited to what the interviewee remembers and what he or she focuses on when asked a question; this is a form of passive data (Dubois and Gadde, 2002), which the interviewers have set out to investigate. However, a preferred method of collecting data would have been to observe the actors in workshops and in meetings. With this method 'active data' would have been attainable, which is associated with discovery (Dubois and Gadde, 2002). Hence, case findings would have been more detailed and nuanced, revealing information that is not attainable through after-the-fact conversations, such as with interviews. Further research is therefore encouraged to follow the collaboration process between SMEs and external actors in a prolonged period through observation and informal conversations, not mere qualitative research interviews. Suggestions for further research is to focus on the drivers of firms' collaboration with academia, i.e. the positive aspects, as well as the specific factors that shape the boundary practices between these two actors from two different worlds – across levels, boundaries, and time. An in-depth understanding of what drives interactions and how this can be managed if possible by the SMEs for self-sustaining boundary practices, independent from regional program or third party facilitation, has the potential to bring the collaborative boundary practices to another level.

7. Conclusions

The findings from these case studies, i.e. small firms' collaborative innovation projects with academic researchers through the regional program (i.e., GTNV-program) have practical implication when it comes to facilitating interactions between the two worlds. In general, many SMEs and small firms do not have the capacity and capabilities to collaborate with academia. SMEs also have shorter time horizons and prefer to engage in shorter projects than for instance larger firms. Many

large firms have people dedicated to collaborate with external knowledge sources including academia, and have the abilities to engage in longer research projects. Although this study focuses on drivers and barriers of small firms' collaborative innovation projects with academic researchers, as the regional GTNV-program specifically targeted SMEs, the findings have implication to practice in larger firms, as well.

There are overall three major findings. Firstly, the structure of the GTNV-program, which is presented in *figure 1*, is staged to initially test whether the firm, academic researcher, and third party match in the *preliminary phase*, before engaging in the main collaborative project in the *main phase*, which lasts approximately one and a half years. SMEs prefer shorter projects, which progress faster than the typical research project lasting several years, and this is a strength of the GTNV-program. The staging of the process ensures progress in the boundary-crossing activities, and this means that the small firms reach results faster, essentially since the scope of the projects is combining existing knowledge – to create context- and situation-specific knowledge that firms can integrate in their operational activities – and not to generate new research results.

Secondly, the elements of collaborative innovation projects shape the boundary practice between the small firms and academia. At its core, the findings are based on projects between people with different backgrounds. With that said, many of the elements must be present when people interact across boundaries, such as the "interaction enablers" and the drivers identified in these cases. Therefore, although these cases are focusing on small firms and their activities with academia, these will to a great extent also have practical implications for larger firms engaging with academia. Nonetheless, reallocating time from daily task to innovative and boundary-crossing activities is potentially the greatest barrier to collaborative boundary practices – regardless whether it is a small or large firm.

Thirdly, facilitating the interactions at two levels, i.e. *meta-level* and *micro-level*, and identifying the roles of the brokers at these two levels, have great practical implications for bridging the gap between firms and academia. One type of broker is the operator that acts as a knowledge broker at a *meta-level* and has a "bird's eye view" over the collaborative boundary practices. The other type of broker is more "hands on" at *micro-level*, facilitating and managing the boundary-crossing activities between the two actors.

We find that particularly the role of a human facilitator of interaction is important in order to overcome challenges at micro-level. We therefore term this role a *broker of human interaction*, as he or she gives a special attention to ensuring open dialogue and face-to-face interaction between the primary actors involved. This we find as an indication for supporting the development of relational capabilities, which Helfat et al. (2007) define as the capacity of the small firm to purposefully create, extend, or modify its resource base by including the resources of external partners.

Overall, coordinating the three phases of the GTNV-program at the *meta-level* and facilitating the boundary-crossing activities between each firm and academic researcher(s) at the *micro-level*, the two types of brokers shape to a great extent the collaborative boundary practices in the innovation projects, which have proven to be useful in overcoming some of the classical barriers firms face when interacting with academia. Essentially, the gap has been mitigated by the structured and formalized interactions facilitated by brokers at both *meta-level* and *micro-level*.

Bridge to *chapter 5*

In *chapter 4*, the three major findings relate to the phases of a structured program, elements of collaborative innovation projects, and the facilitation of interaction at two levels, i.e. *meta-level* and *micro-level* – by two types of brokers.

In the GTNV-program with the process structured in three phases is a staging that ensures progress in the boundary-crossing activities. This has positive implications for small firms, as they reach results faster, since existing knowledge from the different actors is combined and integrated into the firm's operational activities.

In the collaborative innovation projects between the two main actors – small firms and academia – we found the elements and categorized them as *interaction enablers*, *collaboration characteristics*, *main drivers*, and *main barriers*. These elements essentially shape the boundary practices between SMEs and academia.

The collaboration processes in which the projects occur are facilitated by the operator of the GTNV-program at a *meta-level* and therefore acts as a knowledge broker. Another type of broker facilitates the process at *micro-level*, and we term this type of broker, *broker of human interaction*.

The two types of brokers acting at two different levels have proven to be useful in overcoming some of the classical barriers firms face when interacting with academia. The gap between the world of business and the world of academia has essentially been mitigated by the structured and formalized interactions facilitated by brokers at *meta-level* and *micro-level*.

In *chapter 5*, the GTNV-program, and its collaborative innovation projects, is analyzed through the dynamic capabilities framework (sensing, seizing, transforming), as well as we develop a process model of dynamic capabilities for knowledge sharing in collaborative innovation projects. Dynamic capabilities are very difficult to observe empirically; however, the conceptual discussion in *chapter 5* is an important attempt to link the empirical processes to theoretical concepts. The empirical link is illustrated in *figure 2*, where the GTNV-program is incorporated and compared to key concepts in the process model.

The analysis and conceptual discussion in *chapter 5* underscores that small firms, which engage in processes facilitated by the two types of brokers in the GTNV-program are learning to build microfoundations of dynamic capabilities through those innovation activities with external sources – academic researchers. This is a contribution to strategic management and an argumentation for positive outcomes of collaborative innovation projects.

Chapter 5.

Building microfoundations of dynamic capabilities for knowledge sharing in collaborative innovation projects[25]

Diane Filip, Bettina Dencker Hansen,
and Thea Thorsgaard Frølunde

Abstract

Small firms are building microfoundations of dynamic managerial capabilities through collaborative innovation projects with academic researchers and brokers. A Danish regional program, *GTNV-program*, is a formal structure for facilitating collaborative innovation projects between different actors, which we analyze in this study (*figure 1*). We investigate innovation projects through the lens of dynamic capabilities (e.g., Teece, 2007) and analyze the underlying processes of sensing, seizing, and transformation in the small firms by conceptually linking the processes to key theoretical concepts. We propose a process model of dynamic capabilities for knowledge sharing in collaborative innovation projects (*figure 2*), which is an abstract illustration of the complex process relating to concepts within innovation management and knowledge management. Firms discover through what we label *broad exploration* and *specific exploration*, as well as unlock processes to contextualize and apply in the realization phase (e.g., Tranfield et al., 2006). Overall, this study underscores that small firms that undergo processes facilitated by the GTNV-program are learning to build microfoundations of dynamic capabilities through the innovation activities with external sources – academic researchers. These collaboration processes are coordinated and facilitated by brokering activities at *meta-level* and *micro-level* in the GTNV-program. The firms learn to integrate new knowledge into operational activities, through the assistance of *brokers of human interaction*, and thus exploit the fruits of collaboration. Finally, the firms and their CEO build relational capabilities, and over time, they will become better at effectuateing strategic change by including external knowledge resources.

[25] An earlier and extended version of this paper was presented at the University-Industry Interaction Conference, Berlin, June 24-26, 2015.

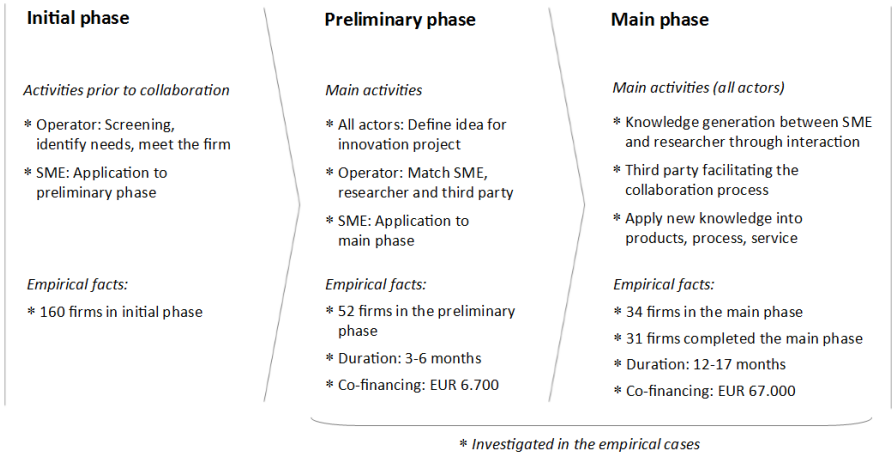
Keywords: Collaborative innovation projects, Dynamic managerial capabilities, Microfoundations, Small firms, Knowledge integration, Process model

1. Introduction

This chapter investigates collaborative innovation projects in order to gain an understanding of capacity and capability building in SMEs collaborating with Academia. We do so by analyzing a formalized and structured regional program – the GTNV-program (*figure 1*) – that makes knowledge sharing and creation processes between SMEs and academic researchers possible through coordination and facilitation at both meta-level and micro-level.

The overall aim is to analyze and compare the underlying processes (i.e., microfoundations of sensing, seizing, and to some degree the transformation capabilities) in the phases of the GTNV-program (collaborative innovation projects) and compare those to the framework of dynamic capabilities (Teece, 2007). Through a conceptual discussion on key concepts within innovation management and knowledge management, we develop and propose a process model of dynamic capabilities for knowledge sharing in collaboration innovation projects (*figure 2*).

Figure 1. The GTNV-program for collaborations between SMEs, academic researchers and independent third party.[26]



[26] For a bigger image, please refer to *chapter 1* or *chapter 4.*

In order to analyze the dynamic capabilities in this context, we investigate the processes in which small firms and their CEOs engage in through the framework as presented by Teece (2007). The dynamic capabilities framework by Teece (2007) proposes a set of microfoundations underlying the sensing, seizing and transforming capabilities; microfoundations through which dynamic capabilities operate. Coordinating, integrating, learning, and reconfiguring are organizational and managerial processes that are core elements of dynamic capabilities (Teece et al., 1997), and "these processes are subsets of the processes that support sensing, seizing, and [transformation]. Together they might be thought of as asset 'orchestration' processes" (Teece, 2007; 1341).

The research methods applied are multiple case studies presented in *chapter 4*. Focus is on process rather than outcome of the collaborative innovation project. The process is set of activities, which constitute collaborative boundary practices. These practices may over time from repeated practice turn into knowledge-sharing routines. Knowledge-sharing routines are "a regular pattern of firm-level interactions that permit the transfer, recombination, or creation of knowledge," and these need to developed and institutionalized (Heltfat et al., 2007; 69).

Tranfield et al. (2006) present generic routines for discover, realization, and nurture in their "D-R-N" process model of innovation, which we in this study incorporate in *figure 2*, a model that links the various concepts in a descriptive illustration. Routines are regular and predictable, collective and tacit, as well as very difficult to observe, measure, or manage in practice (Tidd and Bessant, 2013). Therefore, we cannot fully observe the routines of the SMEs in the case studies; however, we observe the processes in the boundaries between firm and academia through the GTNV-model. Processes coordinated by brokers at meta-level and micro-level and which form collaborative boundary practices.

2. Theoretical foundation

2.1. Knowledge integration for innovation

Moving knowledge from one knowledge base to another generates new knowledge by, for instance, combining existing knowledge in academia with existing knowledge in the industry is an example thereof. Knowledge brokering is a process of recombining existing ideas, artefacts and people; it is about recombining past knowledge and practices in new ways (Hargadon, 2003, 2014). Thus, knowledge is moved through people. In addition, knowledge is necessary for innovation to occur. It stands to reason that individuals engaging in activities, where knowledge is shared through the interaction of human beings, are sources of innovation.

The act of collaborating on something specific with an external partner – such as collaborative innovation projects – is an act of continuous innovation in the firm. Continuous innovation builds on exploration and exploitation capabilities (March,

1991; Boer, 2004; Boer and Bessant, 2004), and the ability of the firm to perform exploration and exploitation tasks call for ambidexterity – a duality of exploration and exploitation (Boer and Bessant, 2004). In simple terms, innovation activities as exploration, and operational activities as exploitation.

Tranfield et al. (2006) developed a hierarchical process model of knowledge management for innovation. This "D-R-N" process model outlines the phases of the innovation process as discover (D), realization (R), and nurture (N), while presenting generic routines for each phase. We incorporate these elements in our process model of dynamic capabilities for knowledge sharing in collaborative innovation projects (*figure 2*).

2.2. Dynamic capabilities, relational capabilities, and microfoundations

Dynamic capabilities concern change (Helfat et al, 2007). Capabilities, including dynamic (managerial), relational, and innovation capabilities, can lead to an enhanced resource base of the firm through purposeful action (Helfat et al., 2007). A capability is the ability to perform a task or activity in at least a minimally acceptable manner (Helfat et al., 2007). It also has a repeated component, as a (dynamic) capability should be reliably executed to at least some extent (Helfat et al., 2007).

The literature on dynamic capabilities is vast and diverse. Seminal works from several authors define dynamic capabilities from various perspectives, including routines (Zollo and Winter, 2002), processes (Eisenhardt and Martin, 2000), capacity as the ability to perform tasks (Helfat et. al, 2007; Teece, 2007) to address changes in the external environment (Teece et al., 1997), as well as, discussions on operational versus dynamic capabilities (Winter, 2003), lifecycle of capabilities (Helfat and Peteraf, 2003), and as entrepreneurship of the firm's decision-maker(s) (Zahra et al., 2006). Zahra et al. (2006) identified a gap in the dynamic capabilities literature, as it historically has predominantly focused on established and large firms, while ignoring new ventures and SMEs.

The definition of dynamic capabilities applied for the purposes in this paper, is "the capacity of an organization to purposefully create, extend, or modify its resource base" (Helfat et al., 2007; 4). Relational capabilities can also be viewed as dynamic capabilities and is the capacity to include external resources – resources outside of the firm's boundaries – when the firm is purposefully creating, extending or modifying its resource base (Helfat et al., 2007).

Felin and Foss (2009) recognize the central concept of *intentionality* in microfoundations and routines in order to arrive at the origin of capabilities. Intentionality, as in each organizational activity, begins with an expectation, belief and associated decisions. Managers make decisions related to activities that may become routinized or organizational capabilities (Felin and Foss, 2009), and the

authors claim that the choices made by individuals are a source of origin. Felin et al. (2012) argue for a multi-level focus on microfoundations of routines and capabilities including individuals, processes and interactions, and structure. Hence, three categories of microfoundations and their interactions. Microfoundations include innovation activities. Moreover, Abell et al. (2008) pinpoint the importance of focusing on microfoundations in the strategic management literature at a micro-level, and argue that macro-level explanations are incomplete.

Managers can create, extend, or modify the firm's resource base by including the resources of external partners (Helfat et al., 2007). These are managerial and relational dynamic capabilities that relate to activities in which change is an essential factor; change in organizational capabilities (Zahra et al., 2006). Managers can develop and apply these capabilities to change in order to survive or achieve competitive advantage (Helfat et al., 2007).

2.3. Entrepreneurial management

A key strategic function of management is to find new value-enhancing combinations of assets and resources – inside, between, and amongst firms – and with supporting institutions external to the firm, including universities (Teece, 2007). Teece states that building and assembling tangible and intangible assets (i.e., knowledge) and effectuating change is perceived as difficult; however, for the firm to build and maintain competitive advantage, it will need to develop and apply sensing, seizing, and transformational capabilities (2007). The first two underlying capabilities (e.g., sensing and seizing) are recognized as fundamental, where sensing does not involve large investment commitments compared to seizing (Teece, 2007).

In relatively stable environments, a firm can be highly competitive for a decade or so by "selecting suitable business models, making the right strategic investment decisions, and pursuing incremental innovation" (Teece, 2007; 1344). All in all, a firm's ability to transform via reconfiguration of resources and to manage competitor threats depends on its investment activity (i.e., seizing), which in turn depends on its ability to sense an opportunity (Teece, 2007), and therefore:

> "Maintaining dynamic capabilities thus requires entrepreneurial management…. Entrepreneurship is about sensing and understanding opportunities, getting things started, and finding new and better ways of putting things together…. Entrepreneurial management has little to do with analyzing and optimizing. It is more about sensing and seizing – figuring out the next big opportunity and how to address it." (Teece, 2007; 1346)

Dynamic capabilities reside mainly with the firm's top management team, who must build and apply all three classes of capabilities, and often utilize them simultaneously; if the CEO has depth in all three of them, the firm has a better chance of success (Teece, 2007).

3. Analysis and conceptual discussion

3.1. Microfoundations in collaborative innovation projects

For analytical purposes, dynamic capabilities can be disaggregated into sensing, seizing, and transformational activities (Teece, 2007); in reality, the world is more complex as such. We find by analyzing the processes of collaborative innovation projects, in which the small firms undergo, that these closely resemble dynamic capabilities framework with the underlying capabilities of sensing, seizing, and transformation and their microfoundations, as described by Teece (2007).

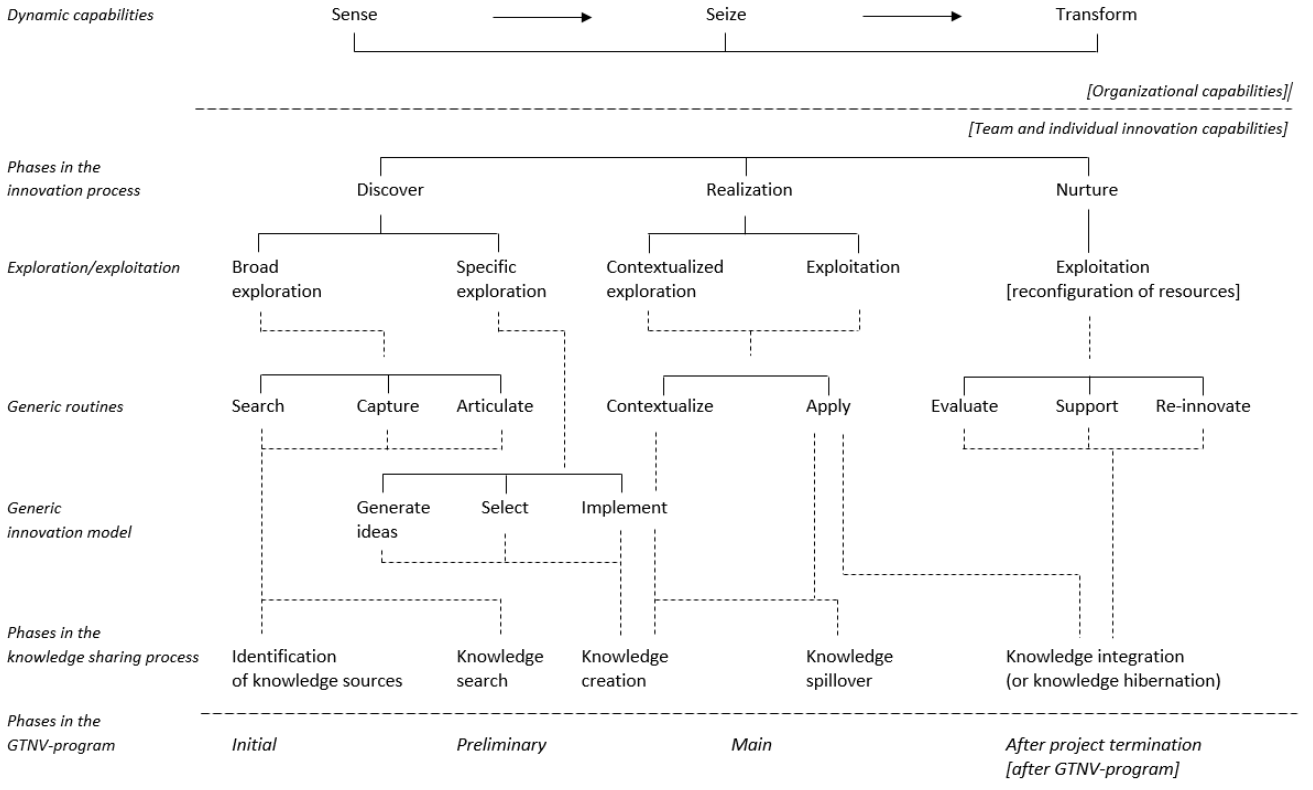
More importantly, Teece underlines that in order to understand, develop, and implement the processes and structures that undergird dynamic capabilities that are firm-specific, requires intimate knowledge of both the firm and the business ecosystem in which the firm competes and cooperates (2007; 1345). This statement pinpoints that dynamic capabilities are very context specific and very difficult to observe empirically, and this is a limitation to this study. We need to assume, theoretically, what goes on empirically at project-level; therefore, the analysis is a conceptual discussion linking theoretical concepts to empirical processes, without being able to observe the actual processes directly.

In this following sections, we seek to link the microfoundations of collaborative innovation projects with sensing, seizing, and transformation capabilities of the framework, and through the GTNV-model and the case studies, we attempt to understand how dynamic managerial capabilities and relational capabilities in SMEs can be built and applied in practice.

The process model of dynamic capabilities for knowledge sharing in collaborative innovation projects (*figure 2*) illustrates the similarities between the case studies in the regional program and research on innovation processes in relation to the dynamic capabilities framework (e.g., Teece, 2007). This model (*figure 2*) incorporates Tranfield et al.'s hierarchical process model of knowledge management for innovation with *phases of the innovation process* – the "D-R-N" process model of innovation – and *generic routines* (2006; 145).

We build on Tranfield et al.'s hierarchical process model of knowledge management for innovation with concepts, such as the phases in the knowledge sharing process, the generic innovation model, exploration and exploitation, and link the microfoundations to the phases in the GTNV-program. We also expand the concept of exploration to the descriptive terms of *broad exploration* and *specific exploration* in the phase of *discover,* and *contextualized exploration* in the phase of *realization*, while we link these to other concepts illustrated in *figure 2*. These are described in the following sections, while analyzing the processes as microfoundations to the capabilities of sensing, seizing, and transforming.

Figure 2. **Process model of dynamic capabilities for knowledge sharing in collaborative innovation projects**



3.1.1. Sensing

Sensing, which includes shaping new opportunities (and sensing threats), is "very much a scanning, creation, learning, and interpretive activity" (Teece, 2007; 1322), and as a complement to these activities, investment in research and related activities is usually needed. The microfoundations of sensing and shaping are compiled of various processes that as a whole underpin the "analytical systems (and individual capacities) to learn and to sense, filter, shape and calibrate opportunities" (Teece, 2007; 1326). Opportunity creation and discovery requires access to information and the ability to sense, shape, and recognize developments, not only search in the context of the particular industry but in the business ecosystem, including potential collaborators, such as customers, suppliers, and complementors, e.g. universities (Teece, 2007).

In the empirical data, the GTNV-program has a preliminary phase where the small firms have to identify opportunities, which are to be shaped in collaboration with academic researcher(s) under the formalized structure. Arguably, the sensing activities begin before their participation in the GTNV-program; the firm searches in its ecosystem and senses an opportunity in participating in the regional program to collaborate with an academic researcher. This is a discovery phase in the innovation process, where the firm undergoes the generic routines of search, capture, and articulate (Tranfield et al., 2006). This we call *broad exploration*, as the firm is identifying its problem to be solved with an academic researcher (i.e., search), spot the need and opportunity for doing something better or different (i.e., capture), and formulate the problem and suggest possible solutions (i.e., articulate) meaning writing the project proposal for the preliminary phase. During this phase, the firm identifies potential knowledge sources followed by a search for specific knowledge (see *figure 2*).

The preliminary phase is an exploration phase for specificity, as the firm is searching for specific opportunities and with searching for key individuals and complementors, e.g. academic researchers with the *appropriate* knowledge base for the particular task identified by the SME. This is also a process of discovery, and we call this *specific exploration*. The firm undergoes a process resembling a generic innovation model, i.e. generate ideas, select, and implement (Bessant and Tidd, 2007). Thus, generating ideas for possible solutions to given problem(s), selecting the pathway to 'solution(s)' to be developed, and implemented. In other words, investing resources – time, money, and people. A more specific project proposal is submitted in order for the firm to enter the main phase – this is where the realization phase of the collaborative innovation project begins.

This sensing activity – to identify the collaborator and the new opportunity – is a learning process for the firm. The firm is learning to sense, filter, shape, and calibrate opportunities (Teece, 2007) in the initial and preliminary phase of the GTNV-program. This process is to a certain extent supported by the operators of the GTNV-program, who assist both with *broad exploration* by helping identifying and

articulating the problem, and the *specific exploration* by finding and matching the knowledge area of the academic researcher(s) to the firm's needs. Nonetheless, prior to the firms' formal participation in the regional program, the firms had processes or individual capacities to sense opportunities – a formal or informal analytical system for broad exploration.

During the preliminary phase, these analytical capacities are further developed by focusing on exploration that is more specific. It may be argued that in larger firms the processes underlying sensing are of formal nature (e.g., specific analytical systems as routines), whereas in smaller firms, these are primarily driven by individual capacity (Teece, 2007) – in small firms, the CEO or other top manager often drives this activity. We argue that the managers are building individual capacity to sense and shape opportunities outside the firm's usual value chain by collaborating with another type of knowledge source – an academic researcher.

3.1.2. Seizing

"Once a new (technological or market) opportunity is sensed, it must be addressed through new products, processes, or services" (Teece, 2007; 1326) which usually requires an investment in development and commercialization activities. The microfoundations of seizing capabilities constitute "enterprise structures, procedures, designs and incentives for seizing opportunities," and include strategic decisions on selecting enterprise boundaries, product architectures, and business models (Teece, 2007; 1334). As stated by Teece (2007), "quality decisions will require uncommon foresight and the ability to shape outcomes" (p.1332). Arguably, the structures and procedures in large firms and multinational corporations, which most research and literature on dynamic capabilities is based on, differ from SMEs – and especially small firms. Teece (2007) proposes a selection of microfoundations for seizing activities; however, the financial reality of small firms and thus the decision-making protocols differ greatly from formalized procedures in large firms.

By entering the main phase of the GTNV-program, the firm engages in the realization phase of the innovation process (e.g. Tranfield et al., 2006). According to Tranfield et al., the generic routines in the realization phase are 'contextualize' and 'apply' (2006). One could argue that the contextualization is an act characterized by exploration, as the firm is exploring how to shape the new knowledge into their context. On the other hand, application is an act of exploitation, where the new knowledge is applied in operational activities. In combination, those constitute microfoundations of seizing capabilities. In other words, in the collaborative innovation projects, a firm is creating new context- and situation-specific knowledge with an academic researcher and applying some of it during the ongoing project, e.g. through knowledge spillover, which is described in the *section 3.2*.

The collaborative innovation project is in itself a channel for *knowledge flow* (e.g., Bessant and Tidd, 2007), and the GTNV-program is an external structure imposing

procedures and incentives for SMEs to make this knowledge flow happen. The regional program finances fifty percent of the firm's overall budget of the project, and the firm invests the other half through hours spent on innovation activities of the project. This might not seem as a lot, however, the small firm is reallocating time from operational activities, e.g. valuable time to make money and exploit its existing competences (March, 1991), by investing time in the innovation project. The time invested in the innovation project is an exploration activity toward gaining new implicit and explicit knowledge (Nonaka and Takeuchi, 1995) – new knowledge to be captured in products or other operational activities. Seizing capabilities, in this context, combine existing knowledge in the firm with existing knowledge from the academic researcher, resulting in new knowledge that is context- and situation-specific – and to be contextualized, absorbed and applied in the firm.

3.1.3. Transforming

Reconfiguring and managing threats is a transformation capability – ongoing activities – with "continuous alignment and realignment of specific tangible and intangible assets" (Teece, 2007; 1340). Successful sensing and shaping, as well as seizing, include decisions to invest in capturing opportunities through products and business models, which can lead to business growth and profitability (Teece, 2007). Teece states that the old and new must complement inside the firm (2007). He also states that intangibles, such as knowledge, are key drivers of performance, and thus are critical to the firm's success. Therefore, the incentive structures designed to facilitate learning and the generation of new knowledge become prominent. Teece draws on the work of Nonaka and Takeuchi (1995) and Chesbrough (2003) and claims that "good incentive design and the creation of learning, knowledge-sharing, and knowledge-integrating procedures are likely to be critical to business performance, and a key (micro)foundation to dynamic capabilities" (2007; 1339).

Transformation – or the ongoing reconfiguration of resources – is in the context of innovation process the phase of 'nurture'. The generic routines for nurture are 'evaluate', 'support', and 're-innovative' (Tranfield et al., 2006). This part of the innovation process cannot be observed in the GTNV-program, as the main part of the collaborative innovation projects are activities underlying sensing and seizing – or discover and realization. The reason for this is that the phase of nurture, when isolating the processes in the GTNV-program, begins when the project is terminated. This is where the newly generated knowledge would be evaluated and reconfigured in order to re-innovate.

Nonetheless, empirical data indicates that these small firms (which have no prior experience with collaborating with academic researchers) find academic researchers relevant for their activities, and perceive them as a value-added partner in their business ecosystem. The collaborative innovation projects have an ending date; however, the small firms are interested in engaging in other projects and activities

with the same academic researcher or with different academic researchers. In some of the cases, the firms are applying for other funding to initiate new collaborative projects – as a continuation of their particular collaborative innovation project. This we find as an indication of an ongoing transformation process of the small firm driven by leadership and top management, as well as an indication of lessons learned and knowledge integration throughout the collaborative innovation project.

3.2. Knowledge management and role of the manager

3.2.1. Knowledge spillover, integration and hibernation

Knowledge spillover and integration is another indication of an ongoing transformation process. The GTNV-program is an example of a framework that underpins the activities for learning and knowledge generation across boundaries, as well as knowledge spillover and integration. It is an example of learning in boundary-crossing activities (Akkerman, 2011). Innovation excellence and strategic excellence is about exploration, and operational excellence is the exploration of, for instance, newly generated knowledge into daily tasks (e.g., Boer and Bessant, 2004).

We find that during the preliminary phase (sensing) and in the main phase (seizing) of the collaboration, learning from the innovation process (boundary-crossing activity) spills over into the operational activities of the firm. For a visual presentation of the concepts of knowledge spillover and knowledge integration (and hibernation) outlined in the process model (*figure 2*), these concepts are illustrated in *figure 3*, showing the process moving from exploration to exploitation by integrating knowledge into operational tasks.

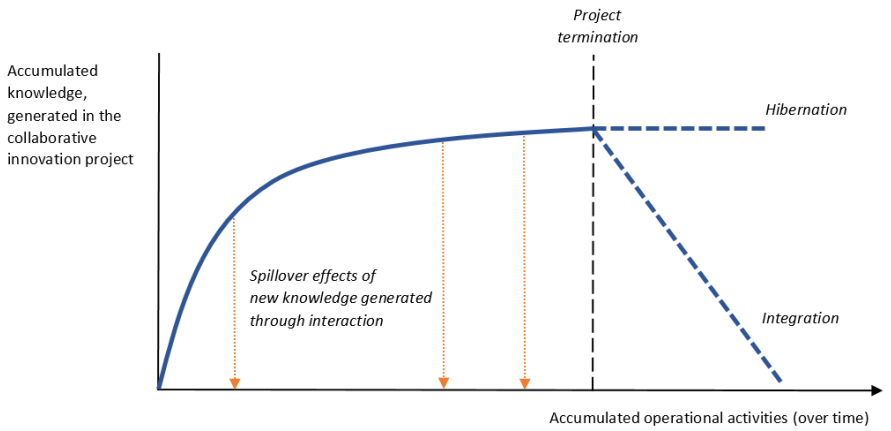


Figure 3. New knowledge generation, integration, and hibernation

Throughout the project period, accumulated knowledge generated in the collaborative innovation project and the spillover to daily operational activities indicate learning through interaction with external sources. The primary (intended) role of the third party is to optimize the interaction between the firm and researcher, as well as to ensure spillover of knowledge into operational activities. Empirical evidence indicates that, during the project duration, this is achieved by asking situation-specific questions on how new information and knowledge created could fit into existing or new processes, products, and capabilities. This ensures that the CEO reflects on the new knowledge, which may be contextualized and applied (e.g., exploitation) through knowledge flow, creation, and spillover within the (small) organization and other operational activities.

Conceptually, we build two distinct scenarios of knowledge *destinations* after project termination: *integration* and *hibernation*. These are observed to a limited extent in some of the cases (towards the end of the projects) and are illustrated in *figure 3*. When the firm manages to absorb the knowledge generated into specific operational activities, for instance, by integrating the knowledge generated into existing and/or new products, processes and/or services – after project termination – we define this as *knowledge integration*. The knowledge is absorbed into existing capabilities or integrated by developing new organizational capabilities with new functions based on the outcome of the innovation project. The phase after project termination relates to the capabilities of transformation, and the innovation phase of nurture, where the knowledge created is evaluated and becomes the outset to re-innovate for further reconfiguration of (knowledge) resources. On the other hand, when the firm fails to apply the knowledge generated into (potential) commercially viable products or services (or into processes) then we define the knowledge destination as *knowledge hibernation*.

We find that at times the activities of the innovation project are the same as the operational activities, thus indicating the new overlapping – or substituting – the old. Capturing the knowledge created in the process into new products or new business scenarios, the small firm partially or fully integrates the new knowledge into operational activities, and to some extent reconfigures its resource base. Conceptually, this is an act of knowledge *integration*. The independent third party assists this process and makes sure that the main actors are interacting in order to create new knowledge to be captured and absorbed predominantly by the firm. We label this role as a *broker of human interaction* (as presented in *chapter 4).* In relation to determining the knowledge destination, the broker of human interaction plays an important role ensuring knowledge spillover and knowledge integration, and avoiding knowledge hibernation where possible.

3.2.2. Role of the CEO in small firms

In order to effectuate strategic change in small firms, the (top) manager's active involvement in this type of collaborative innovation project is arguably a prerequisite to establish and build dynamic managerial capabilities for knowledge creation by including resources of external partners. We therefore and argue for that the act undertaken by the CEO is an intentional act (e.g., Felin and Foss, 2009), and thus purposefully attempting to create, extend, or modify their resource bases – specifically the knowledge base.

The link from the CEO (manager) to operational tasks is relatively close in small firms with a non-hierarchical structure, and therefore suggesting that a transformation in the individual abilities of the manager will transform the small firm's capabilities – over time. The abilities of the managers to sense and seize opportunities are being developed and harnessed through a dialogue-based interaction with external academic researchers and brokers of human interaction by engaging in the discovery and realization phases of the innovation process.

The top manager (and each member of the project team) is undergoing a transformational process by engaging in the collaborative innovation project. This type of transformation occurs at an individual level, and thus we cannot conclude if and how this will affect the ongoing activity of transformation at an organizational level, e.g. the firm's transformation capability (Teece, 2007). Nevertheless, transformation is a form of 'nurture' (Tranfield et al., 2006) of the outcome of the innovation project – and an ongoing reconfiguration of (knowledge) resources.

A repeated pattern of this type of activity will, in theory, lead to dynamic (managerial) capabilities and enhanced relational and innovation capabilities. Entrepreneurial management, including managerial and relational capabilities of top management, is fundamental for the firm's innovation capabilities (e.g., Teece, 2007). Small firms engaging in collaborative innovation projects with external partners to generate new context- and situation-specific knowledge are building as well as applying capabilities to change in order to stay or become competitive – through the active involvement of top management (CEO).

Thus, the ability to integrate and combine assets, such as knowledge, is a core skill (Kogut and Zander, 1992; Grant, 1996; Teece, 2007). The combination of knowledge within the firm, and knowledge between the firm and external organizations (i.e., firms, universities, etc.), is of great significance (Teece, 2007). In the empirical evidence of the small firms, this ability primarily resides with the CEO. It it important to replace the CEO and members of the top management team, if they demonstrate weaknesses in sensing, seizing, and reconfiguration capabilities (Teece, 2007). In small firms, it could be difficult to replace the CEO, as he or she may be the owner. However, the board of directors, or members of it, may be replaced. In the case studies, some of the firms highlight the need of replacing existing members of the board of directors, such that new capabilities would fit the strategic objectives. This

is a result of – or influenced by – the exploration in and realization of the innovation project. In other words, we find that the collaborative innovation projects have an impact and shape the small firm's *emerging* strategy in accordance to the new knowledge generated with external partners (academic researchers).

At the initial phase, the strategic objective of the collaborative project is closely related to the existing strategy of the firm. During the project, the creation of new knowledge opens up for opportunities to integrate new products and services into operational activities. The learning process and knowledge spillover from the innovation project is, in those cases, readily implemented into existing daily operational activities. This indicates that the distance from an independent process (the innovation project) to operational processes is shortened by the active involvement of the small firm's top management. On the other hand, top management can also be one of the greatest (potential) barriers to change. Therefore, the managerial capabilities of the manager – particularly in small firms – are crucial for further developing the firm's capabilities to effectuate strategic change.

4. Concluding remarks

This chapter contributes to theory by linking and aligning dynamic capabilities with more observable processes, such as those described in the literature of innovation management and knowledge management. The process model presented (*figure 2*) and supported by the analysis is an attempt to make dynamic capabilities more tangible, although this is very difficult through an abstract and complex illustration. In other words, linking the various concepts in a process view, we argue that if a firm engages in collaborative innovation projects with academic researchers, through processes that resemble that of the GTNV-program, they build microfoundations of dynamic capabilities – and if executed appropriately, this will lead to effectuating change for positive outcomes.

There are limitations to this analysis and the simplification of dynamic capabilities into three separate capabilities of sensing, seizing and transforming – and their microfoundations. To our knowledge, there are no additional analytical frameworks within the dynamic capabilities literature, which explicitly addresses the microfoundations through an analytical framework. These capabilities are interconnected and cannot be empirically observed separately. Therefore, this analysis contributes to a conceptual discussion of how microfoundations of dynamic capabilities in firms may be build through the means of collaborative innovation projects with academic researchers. As any abstract simplification, there are limitations to direct transferability to other context. However, contributing with an analytical generalization (Kvale and Brinkmann, 2009), the process model is a reflection of empirical research and theoretical concepts in which managers may

gain a theoretical understanding of building dynamic capabilities through collaborative innovation projects.

The analysis and findings underpin important aspects for identifying collaborative innovation projects as the building blocks for microfoundations of dynamic (managerial) capabilities, which through repeated practice may serve as underlying processes for developing these capabilities over time. We have primarily investigated the underlying activities of sensing and seizing – discover and realization of the innovation process (*figure 2*). During the initial phase, the firm engages in *broad exploration* by searching, capturing, and articulating their need for an innovation project within the regional program. The preliminary phase is a *specific exploration* where the firm generates ideas, selects the idea, and finds complementary knowledge assets in the academic researcher(s) as well as implement by investing resources (e.g. time, money, and people). By engaging in seizing activities, including the innovation phase of realization, the firm undergoes processes to contextualize and apply the newly created knowledge – spilled over during the project and integrated after project termination. Transformation have not per se been observed directly, as those are ongoing activities and firm wide – and beyond the scope of the GTNV-program.

For future research, we recommend further empirical investigation into similar collaborative innovation projects between SMEs and external partners for knowledge generation and integration. A special attention is advised to the interactions between the microfoundations underlying dynamic capabilities in SMEs and the development of innovation capabilities. Gathering qualitative data over a prolonged period of time through observation, formal and informal interviews, and action research would be an interesting opportunity to closely investigate innovation capability building in SMEs. We suggest a micro-perspective to gather rich data on individual- and team-level capacity and linking it to organizational capabilities related to change and innovation.

The small firm with its CEO as an active participator in the project gains an insight into a different world – the world of academia – and develops the ability to search for knowledge sources outside their industry and business ecosystem. This is a shift of focus towards collaborating with different types of partners, and an attempt to transform by including external resources into the firm's resource (knowledge) base.

Overall, this study shows that small firms that undergo processes facilitated by the GTNV-program are learning to build microfoundations of dynamic capabilities through the innovation activities with external sources – academic researchers. The firms build relational capabilities, and over time, they will become better at effectuating strategic change by including external knowledge resources. *Broad exploration*, *specific exploration*, and *contextualized exploration* are part of the phases of innovating with external sources. As these collaboration processes are coordinated and facilitated by brokering activities at *meta-level* and *micro-level* in

the GTNV-program, the firms learn to integrate new knowledge into operational activities, and thus exploit the fruits of collaboration.

Bridge to *chapter 6*

Chapter 5 is a conceptual discussion and analysis that pinpoints how difficult it is to observe dynamic capabilities in practice. However, we attempt to make the concept of dynamic capabilities more 'tangible' by analyzing the empirical processes of collaborative innovation projects with the GTNV-model, and find that these may serve as building blocks for microfoundations of dynamic capabilities.

In other words, small firms learn to build and apply dynamic capabilities and relational capabilities by engaging in collaborative innovation projects with external knowledge actors. Over time and with repeated practice, firms develop these capabilities and become better at effectuaring strategic change by including external knowledge resources into innovative and operational activities.

The research conducted in *chapters 4* and *5* are based on five collaborative innovation projects. *Chapters 6* and *7* include three more cases and therefore are based on eight collaborative innovation projects. In the interview guides for these three cases, focus is on objects used in the collaborations. The following two chapters present findings from the use of the *Object Game* in a co-design workshop. The Object Game is both a tool to gather data for research, as well as a tool for the collaborators to reflect on what objects they have used and what roles of the objects used in their respective projects – and why this is important to know for future collaborations.

Introduced in *chapter 6* is an exploratory design game and boundary object – *Object Game* – with its development and design process, as well as its function in collaborative reflection and knoweldge sharing in action. The game itself is applied in a co-design workshop with two of the last three cases conducted, and the objects used by the collaborators are tested in relation to how certain objects facilitate different types of knowledge flows.

Chapter 6 gives an insight into how the Object Game explores existing boundary practices and facilitates retrospection between the actors involved in the collaborative innovation projects. The chapter also introduces ideas to the design of a future-oriented design game playing with possible futures – a *Co-alignment Game.*

These are all essential findings and aspects of boundary-crossing activities in order to shape and define collaborative boundary practices.

Chapter 6.

Designing the Object Game: Collaborative reflections and knowledge sharing in action

Diane Filip and Hanne Lindegaard

Abstract

The Object Game is an exploratory design game and an experiment of developing a tangible object that can spark dialogue and retrospection between collaborative partners and act as a boundary object. The objective of this article is to show and elaborate on the development of the Object Game, and to provide case examples of the game in action. The Object Game has two parts – *Story-building* and *Co-rating of objects* – with the aim of stimulating a collaborative reflection on knowledge sharing with different objects. In *Story-building*, the participants visualize their knowledge sharing process with *Story-cards* by taking the outset in the five meta-objects – Project Proposals, PowerPoint slides, Excel spreadsheets, Meeting places, and an object of own choice. In *Co-rating of objects*, the participants engage in a dialogue and collaboratively rate each of the five meta-objects in relation to how these facilitated *knowledge transfer, knowledge exchange, knowledge generation,* and *knowledge integration.* The participants collaborative reflected on their use of different objects for knowledge sharing and learn which objects have been effective (and which have not been effective) in their collaborative innovation project. Finally, we look ahead to the design of a *Co-alignment game* – a future-oriented Object Game playing with possible futures.

Keywords: Design Game, Design-game-designers, Boundary objects, Collaborative innovation, Knowledge sharing, Knowledge integration

1. Introduction

There is a growing need of establishing possible collaborative practices across organizational and institutional boundaries. Involving individuals with various competences and interests is challenging, and exploratory design games based on participatory design provide designers and facilitators with frameworks and tools to tackle this (Brandt, 2006). The objective of this article is to show and elaborate on the development of the Object Game, and to provide case examples of the game in action. The Object Game is an exploratory design game (Brandt, 2006) and an experiment of developing a tangible object that can spark dialogue and retrospection between collaborative partners and act as a boundary object (Star and Griesemer, 1989; Carlile, 2002).

The Object Game functions as an alternative technique to gather data from key individuals in, and to develop new insights on, collaborative innovation projects. This is a supplement to the retrospective technique of interviewing – a method for engaging the participants to reflect on their collaboration, more specifically the objects used and how those supported the process of knowledge sharing.

The main motivation to develop this type of context-specific game with a specific purpose is to gain an understanding of how the different participants in collaborative innovation projects used objects to share knowledge, as this was not well highlighted in the interviews conducted before the development of the Object Game. Design games and tools emphasize tangibility and visualization, with the underlying concept that "thinking with the hand is a way to reach a richer learning experience" (Gudiksen et al., 2014; 17), and provide the opportunity for mutual learning (Brandt et al., 2008). The Object Game is meant to be both a research method and a boundary object as it unfolds the *how* in a collaboration (e.g., Nicolini et al., 2012), and thus a tool for mutual learning on the *how* of objects in knowledge sharing for collaborative innovation.

In this article, we start by outlining the purposes and functions of design games and participatory innovation, and then we describe the designing process of the Object Game and its use as a research method. We then present the elements of this retrospective tool and discuss the creation of meaning in two case examples by illustrating the game in action. We conclude by discussing the Object Game in relations to exploring existing practices, and we look ahead to a design game exploring possible futures.

2. Purposes and functions of design games and participatory innovation

Design games exploring 'as-is-worlds' and 'as-if-worlds' are tools to involve participants in designing existing practices or designing practices of possible futures (Brandt et al., 2008). Design games in codesign can be viewed as a tool, as a mindset, and as a structure (Vaajakallio and Mattelmäki, 2014). Competition is not the core element of exploratory design games; on the contrary, participants collaborate to complement each other's skills and competences, and do so in a game with rules and tangible game pieces (Brandt, 2006). It is about creating a common understanding of the development task (Brandt and Messeter, 2004). Brandt and Messeter (2004) build on Schön's work (1983) and argue that "constructing scenarios is a design move in the sense that it restructures the current situation to provide new insights" (p.121).

Exploratory design games and board games have the quality of formatting design dialogues (Brandt et al., 2008). The materials aim to support making, telling and enacting, and the visual and tangible components create a platform for a shared focus of attention to establish and maintain dialogues (Vaajakallio and Mattelmäki, 2014). Vaajakallio and Mattelmäki argue that design games offer structure for design game designers, as the games have "tangible design game materials that are explicit while open to reinterpretation, rules and performance roles that can be manipulated depending on contextual needs" (2014; 69). Facilitators can apply design games to orchestrate codesign by engaging multiple stakeholders to express, negotiate and generate a shared understanding of users and contexts (Vaajakallio and Mattelmäki, 2014).

Authors in participatory design emphasize that "designing the process itself is just as important as designing the artefact" (Brandt, 2006; 57). In this article, the process itself is the knowledge sharing process between actors from various organizational or institutional boundaries engaging in collaborative innovation projects. The artefact is the motivation for the collaboration and what triggers it (e.g., Nicolini et al., 2012). An artefact in this context could be tangibles and intangibles in different types of innovations, i.e. product, service, or process innovation. The design game developed and presented in this article is an exploratory design game, the Object Game, which is inspired by the User Game that had the intention to help participants develop a shared image of the intended users grounded in the field data (Brandt et al., 2008).

Figure 1. The storyboard with five meta-objects at the center.

2.1. Context and purpose of the Object Game

The novelty of the Object Game, and the twist as compared to the User Game, is that the participants playing the Object Game are the intended users themselves; and, the data collected through interviews and documents are about the participants themselves. Therefore, the aim of the game is that the participants gain a shared image of their (past) collaboration process, which in turn can give them valuable insights to future collaborative projects. The participants design the knowledge sharing process themselves, as well as negotiate a shared meaning about how different objects have supported knowledge sharing between them and other stakeholders. The main objects – the *meta-objects* – are Project Proposals, PowerPoint slides, Excel spreadsheets, Meeting places, and an object of own choice. The five objects placed on a game board – *Storyboard* (*figure 1*) – are described in a later section.

The act of collaborating with external partners is a form of organizational innovation, where the boundary practice (Akkerman and Bakker, 2011) is incorporated in collaborative innovation projects, which is a mechanism for integrating external knowledge (e.g., Bengtsson et al., 2015). How to manage such collaborative projects, where participatory innovation (Buur and Matthews, 2008) is at heart, is a challenge in itself, as the core assumption in participatory innovation is that various actors contribute to innovation (Buur et al, 2013). Small and medium-sized firms (SMEs) collaborating with academic researchers pose such a challenge, as the actors come

from different 'social worlds' and engage an 'arena' of in-between (Strauss, 1978). This leads to a (possible) transformation of knowledge (Carlile, 2002) and a transformation resulting in profound changes in the practices between the boundaries involved (Akkerman and Bakker, 2011). Real dialogue and collaboration between 'flesh-and-blood partners' at either side of the boundary is essential for transformation and the possible creation of new boundary practices (Akkerman and Bakker, 2011; Engeström et al., 1995). Moreover, design games and tools for designing the process of collaboration may have the power to align expectations and goals of participants from different 'social worlds' (Strauss, 1978) and 'thought worlds' (Dougherty, 2002).

But how can exploratory design games engage participants in a dialogue and interaction to establish a shared image of past or existing practices? And how can we investigate the participants' interpretations of the objects-in-use (Lindberg and Walter, 2013) supporting knowledge sharing for collaborative innovation?

3. Designing the Object Game for collaborative reflection of existing boundary practice(s)

After studying a several collaborative innovation projects between small and medium-sized firms (SMEs) and academic researchers, it became evident that objects play a central role in the knowledge sharing process. The curiosity on how the objects were used for sharing knowledge between different actors started a quest for a better understanding of 'boundary objects' (Carlile 2002; Star and Griesemer, 1989; Star, 2010) and 'objects-in-use' (Lindberg and Walter, 2013), which are objects enacted into being and have specific functions (Law and Singleton, 2005; Lindberg and Walter, 2013). This goes along with Star's argument that "people act toward and with" objects and that their "materiality derives from action" (2010; 603). This could possibly mean that a given object could be used for – or *enacted into being* – one particular function in a certain situation and another function in a different situation, and this is worth investigating further.

Objects then must play a role – and the interesting questions were *what* kind of objects, *how* did the different kind of objects interact, and *how* did the project partners use them?

3.1. The quest for a 'new' method

The first author has as part of the research interviewed the participants (key individuals) about their use of objects for knowledge sharing, and this was limiting and insufficient. The interviewees described their usage, but details on *how, who, where, when,* and *why* were not well articulated through mere conversations in one-on-one interviews. The understanding of how objects were used in the specific context of the interviewee's case was blurred; the interviewed key individuals had at times trouble remembering how he or she had used specific objects in their collaborative projects. The discussions were rather superficial on the topic of objects. Perhaps the notion of objects and their role in knowledge sharing is difficult to grasp through the retrospective technique of interviews, especially when only conducted with one key individual at a time. The interplay between actors and objects was 'lost in translation' – or should we say lost in retrospective description.

This then started a process where questions like these came into play: Is there another method for capturing the interplay between people and objects in knowledge sharing processes? Would it be possible to identify objects through case studies and then incorporate those into a new method? Can a method be designed such that participants of collaborative projects can reflect on their knowledge sharing process through dialogue? Can a relatively simple tool be developed in order to grasp the context in which the most important objects are used in for knowledge sharing?

The search and experiment began, and the first author got inspired by fellow researchers in the participatory design field and especially the development of *design games*. Wanting to untangle design games, the first author initiated a partnership with the co-author in order to develop a method – a board game – and utilize the strengths of visualization and tangibles to encourage dialogue between the actors. Inspired by 'exploratory design games' and 'user games' (Brandt and Messeter, 2004; Brandt, 2006; Brandt et al., 2008), we co-developed the Object Game with the intention of exploring 'as-is worlds' of existing practices (Schön, 1983; Brandt et al., 2008) as an experiment of using the game as a research method. In this case, the existing practices are boundary practices (Akkerman and Bakker, 2011) in collaborative innovation projects.

Figure 2. The development and design process of the Object Game and structure of the co-design session (next page)


1
Multiple case studies – round I:
5 cases – 20 interviews with key individuals (SMEs, researchers, brokers) on the collaboration process & documents (project proposals).
Main objective:
Investigate how SMEs collaborate with Academia through collaborative innovation projects and exploring the role of brokers in a regional program facilitating interactions.
Identifying the elements of collaborative innovation projects: interaction enablers, collaboration characteristics, main drivers and main barriers.
2
Multiple case studies – round II:
3 cases – 6 interviews with key individuals (SMEs, broker) on the collaboration process & documents (project proposals).
Main objective:
Investigate the process of collaborative innovation projects (as in round I) and this time with a special focus to gain an understanding of the role of objects for knowledge sharing. Identifying objects used, i.e. PowerPoint, Excel, blueprints, etc., and developing a descriptive classification of objects-in-use: spatial objects, structural objects, sparring objects, and situational objects.
3
Designing the Object Game:
Multiple case study analysis and co-design of game material with co-author.
Main objective:
Building the foundations of the game by analyzing the multiple case studies in order to identify objects used in collaborative innovation projects. Five meta-objects were identified in all cases: Project proposal (Word), Meeting places, PowerPoint, Excel, and an object central to the collaboration, i.e. boundary object. Other objects are identified and incorporated into the Object Game as story-cards.
4
Co-design workshop with 2 cases – from round II:
Four participants from 2 cases; Case Alpha (CEO & broker) and Case Beta (Creative director & academic researcher)
Tuning-in:
5 theme cards with quotes from interviews (round II) initiate discussions among participants.
Story-building:
Co-constructing the knowledge sharing process by configuring objects with story-cards on a storyboard – and storytelling with meta-objects as the starting point.
Co-rating of objects:
5 meta-objects rated in relation to knowledge transfer, knowledge exchange, knowledge generation & knowledge integration.
Reflection:
Participants share their interpretations, experiences, lessons learned from the Object Game – and further use of new insights.

3.2. The development and design process of the Object Game

Figure 2 describes the process of developing the Object Game – the layout of the illustration is inspired by Vaajakallio and Mattelmäki (2014). The development process included multiple case studies (round I and round II), followed by the development of a descriptive classification – four S' of objects-in-use. The Object Game is based on multiple case studies, e.g. eight collaborative innovation projects. Each project constitutes of one SME, one or more academic researchers, and an independent third party.

As illustrated in *figure 2*, the co-design session (e.g., workshop) contained four parts: *Tuning-in* is a warm up followed by the two parts of the Object Game; *Story-building*; *Co-rating of objects*; and, finishing with *Reflection* at the end of the session. These elements are described in later sections.

3.3. Choices made and reflections on the game material

In the designing process of the exploratory design game, choices were made along the way. First, the game had to include elements from the cases, therefore objects identified in the case studies. Second, the participants of the game had to include the CEO or a top manager and their external partner in their collaborative project. Third, the game materials needed to resemble some 'known' game, such as board games with tangible pieces, though with a professional design signaling that this game is not just for the fun of playing games but has a specific purpose. The design of the game should help the participants to reflect retrospectively.

When designing the game board and game pieces, we were inspired by the User Games with Moment-cards and Sign-cards (Brandt and Messeter, 2004; Brandt, 2006; Brandt et al., 2008). We chose a design of a game board that would signal a common ground for the participants, as well as a board with a center circle: Starting at one spot and going around – closing the loop – and thereby signaling a 360-degree dialogue. We call this game board the *Storyboard* as this is the platform where the dialogue takes place, and where a story is built through collaborative reflections on their knowledge sharing practices with different objects.

Figure 3. Early version of game pieces (left) and an example with final version of Story-cards (right).

As for the game pieces, we wanted to make sure that the participants had not played with similar pieces before in a business setting; therefore, we explicitly chose not to use LEGO and Post-its. For the *Story-building*, we chose colorful carton with images and text (*figure 3*). The sizes of these cards was also of importance, as many cards would be placed on the game board, and there needed to be space to line them up. These cards – the *Story-cards* – are different types of objects that are divided into six categories: *Who? Where? How? What? Why? When?* (i.e., category-cards). Each category with its own color and category-card (see *figure 4* in a later section). Using different colors makes it visually easier to distinguish between the categories (assuming the participants are not colorblind). Each card represent a piece of an overall story to be told – by combining the story-cards on who, where, what, how, why, and when.

In the designing process of *Co-rating of objects*, we discussed using elements that were easy to place, steady (unlike pearls), and that had no food resemblance, so we excluded possible candidates like pasta, beans, M&M's (chocolate candy). We decided to go with something more neutral yet colorful: orange and blue mosaic stones (see *figures 7* and *8* in a later section). The board for the Co-rating of objects also needed to be one platform (a matrix) where the participants could have a dialogue and interact with the game materials.

4. Using the Object Game as a research method

The primary aim of developing the Object Game was to use it as a research method in an attempt to understand combinations of different objects and their role in knowledge sharing. This game is a way to simplify a complex innovation process and

to capture (part of) the complexity of the interplay between individuals and objects. This study is based on the co-design session and conversation analysis (Buur et al., 2013) where the researchers facilitate experiments in participatory design workshops – co-design workshops (Vaajakallio and Mattelmäki, 2014) – to engage participants in testing collaborative tools (Gudiksen et al., 2014). Other researchers have used co-design techniques or participatory designs, i.e. improvisational theatre, as a research method in order to understand the emergence of meaning through conversation and real dialogue, especially the quality of the conversation between participants with crossing intension (Buur and Larsen, 2010).

In a half-day workshop, the participants used the Object Game to retrospect on their collaborative project, and to reflect on how they – through different objects – have shared knowledge. At the end of the session, participants engage in a reflection to share their lesson learned and to evaluate the elements of the workshop. The workshop-session is video recorded for visuals, including photos, on dialogue and interactions between participants. Audio recordings in combinations with video recordings and photos are used to capture the meaning of the participants themselves as they interact and create 'meaning' with the pieces of the game. Nonetheless, as this is an experiment built on other authors contributions to the literature on exploratory design games and participatory design (e.g, Brandt, 2006; Vaajakallio and Mattelmäki, 2014), its simplicity might just highlight the complexity of knowledge sharing processes in collaborative innovation projects. Hence, this only carves out a fraction of human interaction supported by objects – and not reveal the full picture.

4.1. Developing a classification of objects in knowledge sharing processes

Prior to the co-design workshop, a descriptive classification describing the attributes of objects-in-use was developed. This classification is the *four S' of objects-in-use* consisting of *structural objects, spatial objects, sparring objects*, and *situational objects*[27]. The Object Game itself is a *sparring object* in the four S' of objects-in-use classification. A boundary object describing the *how* of the collaboration, but does not explain what triggered or fueled it (e.g., Nicolini et al., 2012). It only eludes to the fact that the primary boundary object of the collaborative project is the object worth the most to the participants – the *situational object* – the object of own choice in the Object Game.

An abstract categorization of knowledge sharing processes as four types of knowledge flows is used in the co-desing workshop. The four types of knowledge flows[28] are defined as follows: *1) knowledge transfer* as a one-way flow*, 2) knowledge exchange* as two-way flow*, 3) knowledge generation* as the creation of

[27] See *chapter 7, table 1,* for definitions.
[28] For a description of the four types of knowledge flows, please refer to the theoretical lens in *chapter 3* or *chapter 7*.

new knowledge*,* and *4) knowledge integration* as the capture newly generated knowledge. These represent the movement or creation of new knowledge to be captured into the firm's existing or new processes, products, or services. This categorization is integrated into the second part of the Object Game – *Co-rating of objects* – to explore how the participants interpret the role of the five main objects (i.e., *meta-objects*) in supporting the different types of knowledge flows in their collaborative projects.

5. Elements of the Object Game – a retrospective-reflection tool

As Albert Einstein once said, *"Everything should be made as simple as possible. But not simpler."* There is a fine line between, on one hand, designing a game that will capture the most important aspects, and on the other hand, making it too complex for the participants to understand. This game is based on the specific contexts of collaborative innovation projects studied in the multiple case studies of a Danish regional program 2011-2014 – *Genvej til Ny Viden* (Shortcut to New Knowledge). Therefore, the *tuning-in* in the workshop (*figure 2*) as a warm up for (and not part of) the Object Game included five theme cards[29] with quotes from the interviews in round II: *1)* Knowledge-based collaboration, *2)* Chemistry, *3)* Dialogue & Interaction, *4)* Knowledge, and *5)* Innovation.

Overall, the Object Game has two parts – *Story-building* and *Co-rating of objects* – with the aim of stimulating a collaborative reflection on knowledge sharing with different objects. The following sections introduce the various elements of the game: *Meta-objects, Story-building,* and *Co-rating of objects*.

5.1. The Meta-objects

Each collaborative innovation project is unique; however, some objects reoccur in all eight cases, including *Project Proposals* (written in Word), *PowerPoint slides*, *Excel spreadsheets*, *Meeting places*, and an *Object* that is at the center of the collaboration. The latter is a boundary object that, as Nicolini et al. (2012) state, has the capacity to explain what motivates and fuels the collaboration. Most objects fall in the category that facilitate collaboration but does not trigger (Nicolini et al., 2012), including the first four objects. The five objects are referred to as *meta-objects* as the interconnectivity and interplay between different objects and individuals will be displayed by starting with one meta-object at a time (*figures 1, 5 and 6*); starting with Project Proposals, followed by Meeting Place, PowerPoint, Excel, and 'Object of own' choice.

[29] The five theme cards are presented in *Appendix F.*

Figure 4. The Story-cards with images, short text (and blank cards), and different colors categorized according to Who? Where? How? What? Why? When?

5.2. The Story-building

The first part of the Object Game – *Story-building* – consist of a *Storyboard* with space for placing the five meta-objects, as a starting point of the story building (*figures 1, 5, and 6*). *Story-cards* are categorized into six groups of *Who? Where? How? What? Why? When?* (*figure 4*). These are placed on one table separate from the Storyboard (*figure 5*). The categories have different colors, making it easier for participants to distinguish them. Each story-card with a picture and short descriptive text for *Where? How? What?*, just a short text for *Who? Why?*, and blank cards for *When?*.

As the story-cards (objects) were identified in the case studies, blank cards are provided in order for the participants to include more objects than were evident in the cases. Something could have been (and most likely was) missed out in the interviews or documents, and blank cards give the participants the chance to add nuances to their story on knowledge sharing (*figures 4, 5 and 6*). Once the story-building for the first meta-object is completed, then the next meta-object is presented and story-cards for this objects are placed on the storyboard.

Figure 5. The Story-cards were placed on one table (left) and the Storyboard with Story-building on another table (right). The participants co-created their story of existing practices through dialogue and interaction.

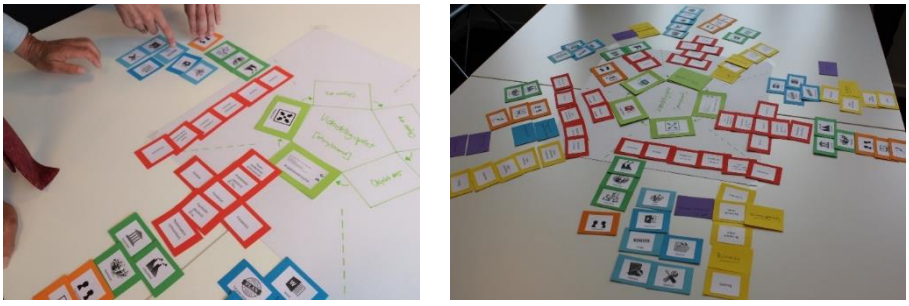


Figure 6. Example of Story-building: In action (left) this is the platform sparking storytelling (right).

5.3. The Co-rating of objects

The second part of the Object Game – *Co-rating of objects* – is a matrix (*figures 7 and 8*). The purpose of *co-rating of objects* is to make the participants reflect on how the five meta-objects support knowledge sharing – and to which degree. Participants, through dialogue, in collaboration rate each meta-object by placing colored stones in the matrix (platform). To the left in the matrix (vertically), the five meta-objects are placed (*figure 7*), and horizontally the four types of knowledge flows are rated according to *knowledge transfer, knowledge exchange, knowledge generation,* and *knowledge integration*. These four types may occur parallel and may be iterative. Definitions of the four types are provided on cards next to the co-rating of objects platform. Each object can score from zero to five stones: *0=not relevant; 1=low degree; 2=lesser degree, 3=some degree, 4=high degree; and, 5=very high degree*.

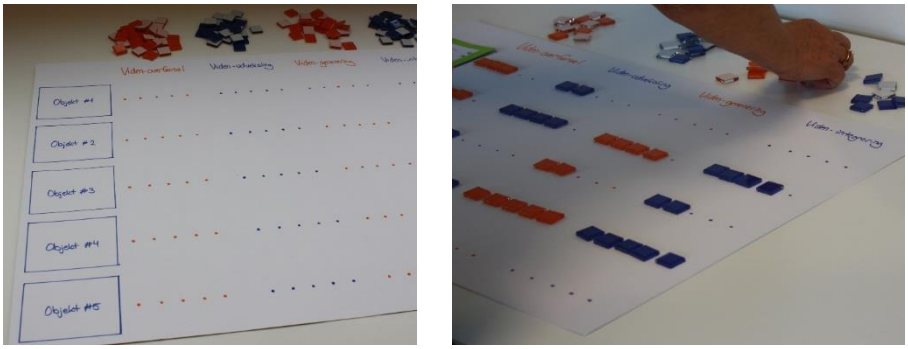


Figure 7. The Co-rating of objects: Meta-objects to be placed in the empty space (left) and co-rating in action (right).

6. Dialogue and interaction to establish meaning

We have thus far described the process of developing and designing the Object Game, and we have presented the tangible elements of the game. However, to understand the participants' interaction with the elements of the game, we present in the following sections two cases – *Case Alpha* and *Case Beta*. Transcripts from the workshop provide a better understanding of the Object Game, *Co-rating of objects* (see *figure 8*) in action, and through conversation and interaction analysis, we describe the emergence of *meaning* of a given object through dialogue (Buur and Larsen, 2010).

Figure 8. The Co-rating of objects: Participants in Case Alpha engage in a dialogue when placing tangible pieces (left) and a finished example of this activity (right).

6.1. Co-rating of objects: Case Alpha on 'Excel'

Case Alpha is a collaborative innovation project between a manufacturing firm (SME), Danish and German researchers, and a broker (with a role of an external project manager). Case Alpha focused on process innovation and the two representatives of Case Alpha were the chief executive officer (CEO) (*A*) and the external project manager (*B*). By following the two participant's dialogue and interaction during the workshop, and later analyzing the audio of their conversation, we can see that the creation of meaning is supported by examples from real life, moments of retrospection, and confirmation from the other participant.

In Transcript 1, we observe that the two participants of Case Alpha use real life examples to support the abstract categorization in the *Co-rating of Objects*, and thus how many stones should be placed at each category of knowledge sharing. In order for the participants to make the object more tangible, they relate to Excel as an object for placing test results, and articulate real life examples on how individuals have interacted with this object.

Transcript 1.
Case Alpha: Dialogue and interaction on 'Excel.' (Transcript is translated from Danish.)

A: Excel. Well, there were test results placed there.
B: Yes. There was, in fact, a lot here.
(Places some stones at knowledge exchange)
Right?
A: Yeah, it was knowledge exchange…
B: Exchange… I would actually place…
(Places 5 stones at knowledge exchange)
… because *[Researcher]* could not have finished, if *[X]* had not received the results from you.
A: No, No…
B: There, I would almost do like this…
(Places 2 stones at knowledge transfer)
A: Yes. No more on that one.
B: No.
A: And then there was… Was new knowledge generated? Yes, there was…
B: Yes, there was a lot! So compared to…
A: Well, there we need to place some, as well.
B: It did. Yes…
(Places 4 stones at knowledge generation)
Well, there were some aha-moments related to filling these out or when used as tools…
A: You could also see, which cutting data you could use.
B: Yes, exactly!
A: And there was also some knowledge integration.
B: Yes. I would almost give it five here... since it is probably this one that has created the most…
(Places 'only' 4 stones at knowledge integration)
A: Yes.
B: Because it is also visualized! And because they worked with it themselves *[the workers]*

In the dialogue, *A* relates to Excel as an object with test results, and this is confirmed by *B*, and goes on to place maximum number of stones at *knowledge exchange* and support this action by giving an example, "… because [the Researcher] could not have finished, if [X] had not received the result from you," which is acknowledged by *A*. Another example when the co-rating is supported by real life example: *B* strongly confirms that knowledge has been generated knowledge and gives an example, "Well, there were some aha-moments related to filling these out or when used as tools…" *A* builds on this example and elaborates on the object as being a visual tool for practical use, "You could also see, which cutting data you could use," and *B* agrees with this statement, "Yes, exactly!".

The participants realized, through their own reflection on their use of objects in specific situations, that individuals inside the firm and external to the firm have interacted with this particular object to transfer and exchange information, in order to generate this information into context-specific knowledge, and thereafter integrating it through the active use.

6.2. Co-rating of objects: Case Beta on 'PowerPoint'

Case Beta is a collaborative innovation project between a service firm (SME), Danish researchers, and a broker (with a role of facilitator) – a case focusing on service innovation. The two representatives of Case Beta were the creative director (one of two owners) (*C*) and academic researcher (*D*). The transcript is an example of a dialogue and interaction between the two participants, which through conversation and interaction analysis from video and audio recordings, illustrates the implicit understanding and interpretation of the given object in question – PowerPoint.

As we observe in Transcript 2, the dialogue between the two participants in Case Beta is rather implicit in the sense that their interpretation of the object in relation to the four abstract levels of knowledge sharing is not explicitly supported by real life examples, as compared to Case Alpha. The use of the tangible stones and visual categorization give the participants a visual platform to engage in a dialogue to emerge at a common meaning of the object – PowerPoint – in their collaborative project. For example, when discussing *knowledge integration*, *D* pinpoints that "It has also been important in…" and *C* finishes his sentence, "knowledge integration." *D* asks, "To some degree or to a high degree," where *C* wants to clarify, "It is important over here… knowledge integration. Isn't it?" – and *D* confirms. Overall, the participants give meaning to PowerPoint as being an object that in their context functioned as an object supporting the integration of knowledge into the firm.

Transcript 2.
Case Beta: Dialogue and interaction on 'PowerPoint.' (Transcript is translated from Danish.)

C: PowerPoint?
D: Well, it was both knowledge exchange and knowledge transfer, right? It is quite important here, right?
(Places 5 stones at knowledge exchange)
C: Yeah…. Transfer, here.
(Places 3 stones at knowledge transfer)
D: It also has a degree of knowledge generation.
(Places 3 stones at knowledge generation and one more at knowledge transfer)
C: Do you want four on this one? [Knowledge transfer]
D: Yes. I think, in fact that…
C: And then we place them like this.
(Moves stones, so they are not aligned at knowledge transfer – to have space between the third and fourth stone)
D: Yes. It has also been important in…
C: Knowledge integration.
D: To some degree or to a high degree?
C: It is important over here… knowledge integration. Isn't it?
D: Yeah.
C: So I will rather have five over there *(points at knowledge integration)* than I want four here *(points at knowledge generation).*
D: (Places 5 stones at knowledge integration)

Through the participants own reflection on their use of this object for knowledge sharing, they realize that knowledge was predominantly generated though face-to-face dialogue and drawings on a (physical) whiteboard. PowerPoint was used as a reporting tool, thus instead of writing a long report in Word, PowerPoint captured the most important aspects, and is an effective reference for further use.

6.3. Outcome of the dialogues and interactions

Through the conversation and interaction analysis, we have shown how the participants engage in a reflective dialogue to establish a common meaning on the object in question. The interaction with the pieces (meta-objects and stones) in the *Co-rating of objects* focuses their attention on a given object, in relation to the four abstract levels of knowledge sharing – transfer, exchange, generate, integrate. For instance in Case Alpha, the participants compared the four abstract categorizations to real life examples, and thus giving the objects meaning and contextualizing knowledge sharing. Moreover, if the participants had not completed the first part of the Object Game – the *Story-building* with several Story-cards – then the co-rating of objects would have been too abstract. The participants would have had troubles relating to these objects and their context.

The conversation and interaction analysis of the two cases highlights how the participants interpret the objects as supporting the knowledge sharing process in collaborative projects. The participants of Case Alpha engage in a dialogue with real life examples to substantiate their moves and placement of stones, which gives researchers (the authors) a better understanding of the use of for instance Excel in their contexts. On the other hand, through Transcript 2, it is not evident how Case Beta had used PowerPoint in their collaborative project, and only through a separate discussion did they explain the interaction with other objects and how those have been combined.

By analyzing the dialogue and interaction of *Co-rating of objects*, we also observed that the tangibles and visual pieces give the participants the opportunity to reflect on their (and others) behavior when for instance interacting with and through Excel and PowerPoint. The results of the ratings underscore the participant's interpretation of the five meta-objects in relation to the four abstract levels, thus *how* they interpret each object in relation to facilitating knowledge sharing. However, these ratings do not explain *why* the objects were used as they were. We only find the explanations when real life examples are given in the dialogue, or by further questioning alternative uses of objects supporting knowledge sharing.

7. Discussions

We conclude the article by discussing and reflecting on the Object Game as a research method and a boundary object. A game that both helps the researchers to collect data on different objects in knowledge sharing – and to use it as a tool to spark dialogue, interaction, and retrospective reflections between participants. Board games have qualities of formatting design dialogue (Brandt et al., 2008) and we look ahead to play with thoughts on reconstructing the Object Game to include elements in which 'as-if-worlds' of future practices could be explored (e.g., Brandt, 2006).

7.1. The Object Game as a 'sparring object'

The exploration of the 'as-is-world' of this design game (Brandt, 2006) – with *Story-building* and *Co-rating of objects* – gives the participants the vantage point from a bird's eye, which enables them to grasp a conceptual totality (Johansson et al., 2002). Together with the participants, we evaluated the Object Game. Playing the Object Game was a learning process for the participants, as they reflected on their use of different objects for knowledge sharing and learned which objects had been effective in their collaborative project, and which objects had not been effective. This collaborative retrospection through dialogue gives the participants, as well as the design game designers (authors), new insight into the use of different objects in knowledge sharing processes. Playing the Object Game has developed the abilities

of the project partners to identify which objects they can use more strategically in their future collaborative projects. Additionally, as design game designers, we did not have to facilitate the dialogue; an introduction to the game rules was sufficient, and this is an indication of a game design that is intuitive and self-directing.

It was interesting to observe how Case Alpha and Case Beta approached the Object Game. In the *Story-building*, the participants placed the story-cards by categories (colors) and thus answering the question on the category-card, for instance, starting with *Who?* and placed the most important story-card (object) in each category. In their storytelling, they pinpointed their logic in placing the story-cards as they did – horizontally in Case Alpha (*figure 5*) and vertically in Case Beta (*figure 6*).

In *Co-rating of objects*, Case Alpha chose a systematic approach by intuitively starting from the top with meta-object number one (Project Proposal), going from left (knowledge transfer) to right (knowledge integration). Case Beta, on the other hand, started from the bottom meta-object – object of own choice – and their argument was that this object was the most important for their collaboration, and they started by placing stones at knowledge generation and integration. Both approaches were equally functional.

The Object Game is in itself a boundary object, as we learned through conversation and interaction analysis of the two transcripts. A boundary object is "both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star and Grisemer, 1989; 393). The board games in the two parts of the Object Games are enacted into being a *sparring object*, according to the four S' classification, as the object facilitates interpersonal communication, knowledge transfer and exchange between the participants, and some knowledge generation by reflecting and learning something new through their dialogue. Additionally, knowledge integration may occur as the participants integrate their learning, from interacting with each other and the game pieces, into future practices with knowledge sharing processes.

Nonetheless, as researchers and design game designers we need to accept the fact that engaging key individuals to interact and simply place tangible game pieces on a visual platform cannot convey the whole truth on the different uses of objects in collaborative projects. Through conversation and interaction analysis, we can gain an understanding of how the participants themselves make sense of their use of objects in knowledge sharing (e.g., Buur et al., 2013). In *Co-rating of objects*, each meta-object is rated in isolation, thus it does not underline the interaction with other types of objects; reality is more complex as such. When participants discussed how to rate each meta-object, the dialogue placed each meta-object in relation to other objects, similar to the *Story-building* part of the Object game. Nevertheless, this simplification does however spark a dialogue that carries a story more nuanced than when investigating the role of objects through one-on-one interviews. As such, the method of Object Game, and design games in general, functions as a hands-on tool

to bring about meaning to complex processes, such as knowledge sharing between various actors for collaborative innovation.

7.2. Playing with possible futures of collaborative practices

As design game designers, exploring possible futures or 'as-if-worlds' (Brandt, 2006) is a natural step in the development of a *Co-alignment game* with participants who want to start a collaborative project. Aligning expectations of actors from various organizational and institutional boundaries could be the outset to create a common playing field in a design game – a board game – with game pieces to design future collaborative projects.

In a cross-section of design and strategic innovation for business success, John Bessant states, "Design is essentially the application of human creativity to a purpose – to create products, services, buildings, organisations and environments which meet people's needs. It is the systematic transformation of ideas into reality, and it is something which has been going on since the earliest days of human ingenuity" (Bruce and Bessant, 2002; 3). Designing a game that functions as a tool triggering the application of human creativity to a specific purpose is the case at heart for designing a future-oriented object game. People's needs in that case would be the needs of the collaborative partners combined with user needs.

An interesting further development of the Object Game would be to explore the possibility of a managerial process tool to facilitate future collaborative projects between various actors by incorporating elements from the design thinking literature (e.g., Simon, 1969; Schön, 1983; Buchanan, 1992; Martin, 2009; Johansson-Sköldberg et al., 2013). Depending on the nature of the problem in the collaborative project, if the problem is human-centered and identifying user needs is essential, then these problems could be addressed through design thinking approaches (Liedtka and Ogilvie, 2011). Liedtka and Ogilvie (2011) present the design thinking process with an outset in the four questions of *'What is? What if? What wows? What works?*' as the authors provide ten tools for practitioners on *how to do design thinking*.

Identifying elements for a process tool that underscores the systematic transformation of ideas of participating actors would arguably set the collaborative partners central to the game, in relation to the discovery process of wicked problems (Buchanan, 1992) or human-centered problems (Leidtka and Ogilvie, 2011), as well as in relation to objects used for knowledge sharing in future collaborative innovation projects. These four questions (in *table 1*) combined with the four-level hierarchy of knowledge sharing could assist collaborators to first explore with question of 'what if?' and 'what if?', and then move gradually from exploration to exploitation with questions of 'what wows?' and 'what works?'.

Suggestions for further research include identification of possible object candidates to support the process of solutions- and collaboration-based knowledge exploration and exploitation, as illustrated in *table 1*. Those could build on the descriptive classifications of structural objects, spatial objects, sparring objects, and situational objects or Nicolini et al.'s classification of primary, secondary and tertiary objects (2012). This type of design game would set the collaborative partners central to the design of (future) knowledge sharing processes; the game itself becomes a tool for the partners to structure their collaboration and thereby gives special attention to future use of objects for knowledge sharing in order to address user needs through a systematic transformation of ideas into reality.

Design thinking approach	What is?	What if?	What wows?	What works?
Knowledge phase	Explore	Explore	Explore Exploit	Exploit
Knowledge sharing (four types of knowledge flows)	▪ Knowledge transfer *(one-way knowledge flow)* ▪ Knowledge exchange *(two-way knowledge flow)*	▪ Knowledge exchange *(two-way knowledge flow)*	▪ Knowledge generation *(creation of context- and situation-specific knowledge)*	▪ Knowledge generation *(creation of context- and situation-specific knowledge)* ▪ Knowledge integration *(absorption of new knowledge)*
Identification of possible object candidates (descriptive classification)	← o Structural objects o Spatial objects o Sparring object o Situational objects →			

Table 1. Envisioning the Co-alignment game:
A future-oriented design game playing with possible futures.

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A special thanks to the companies and their external project partners for participating in the co-design workshop and for sharing your experiences, reflections, and insights on knowledge sharing in collaborative innovation projects.

Bridge to *chapter 7*

Chapter 6 presents the experiment with developing a design game to function as a research tool and a boundary object for collaborative retrospection of the actors engaged in collaborative innovation projects (a reflective tool). The Object Game uses the five main objects – meta-objects – found in the multiple case studies (collaborative innovation projects) in the two parts of this exploratory design game: *Story-building* and *Co-rating of objects*.

The participants in the co-design workshop place the meta-objects in a context through the story-building part of the Object Game, where the participants engage in a reflective dialogue on how they have used the objects in their collaborative innovation project. The co-rating part is facilitating a more evaluative dialogue, as the participants are discussing their own interpretation of how certain objects have facilitated different types of knowledge flows – transfer, exchange, generation, and integration.

We learn that it is possible to investigate and explore the role of objects with a different method than qualitative interviews. With that said, interview data was attained and analyzed before the development of the design game, and thus interviewing key informants is an important step in designing an exploratory design game that can explore the role of objects even further. The dialogue facilitated by interacting with the game pieces is of a different nature than conversations in interview settings. As a researcher using this research tool, gives a more nuanced picture of the collaborations and objects used to facilitate knowledge flows. For the collaborators (participants in the Object Game), the reflective tool gives them a new insight and perspective on their use of objects – and 'food for thought' for future collaborations.

These findings also indicate that such a design game is valuable in 'closing the loop' in a project with external actors – as they reflect on their process and what they have learned. If this game has been useful in retrospection, why could a similar design game not be valuable in a forward process, as in a *Co-alignment game*?

In *chapter 7*, the development of the descriptive classification – the *four S' of objects-in-use* – is presented more in depth (briefly introduced in *chapter 6*) through an analysis of the objects identified in the eight collaborative innovation projects. In this chapter, definitions of the four objects – *structural, spatial, sparring* and *situational* – are presented. The four S' classification is discussed in relation to the findings from the story-building and co-rating parts of the Object Game.

Overall, *chapter 7* explores the role of objects in collaborative innovation projects, how the different objects and their combinative use play a role in knowledge sharing processes between SMEs and academia.

Chapter 7.

The role of objects in collaborative innovation projects[30]

Diane Filip

Abstract

The objective of this paper is to explore the role of objects in small and medium-sized firm's (SME) collaborative innovation projects with academic researchers. This study explores how key individuals have enacted objects into being (Law and Singleton, 2005; Lindberg and Walter, 2013) in collaborative innovation projects, and how objects-in-use (Lindberg and Walter, 2013) facilitate knowledge flows between two of more knowledge bases. A descriptive classification of objects is developed, the *four S' of objects-in-use,* which includes four types of objects: *structural, spatial, sparring,* and *situational objects*. These descriptive classifications of the objects 'signal' their role in practical terms – how they have been enacted into being in action. Five main objects have been identified in multiple cases and those are *Project Proposals, PowerPoints, Excel, Meeting places,* and an *Object* that is central to the collaboration. The latter is the primary boundary object that has the ability to explain what motivates and fuels the collaboration (Star and Griesemer, 1989; Carlile, 2002; Star, 2010; Nicolini et al., 2012). In a co-design workshop, the role of the five main objects are tested in an exploratory design game (Brandt, 2006; Brandt et al., 2008) – the *Object Game* – in relation to how they facilitate four types of knowledge flows – *transfer, exchange, generation,* and *integration*. In the findings, we can see that one object can be enacted into two or more types of objects, depending on intentions (*why*), usage (*how*), timing (*when*), and context (*where*).

Keywords: Boundary object, Objects-in-use, Knowledge sharing, Knowledge integration, Collaborative innovation

[30] A previous version of this paper was presented at the *16th International CINet Conference* in Stockholm, September 14-15, 2015. Conference paper "The role of objects in knowledge sharing for collaborative innovation" in the *Proceedings of the 16th International CINet Conference: Pursuing Innovation Leadership*, Stockholm, pp. 267-277.

1. Introduction

The objective of this chapter is to explore the role of objects in collaborative innovation projects, and to develop a classification of objects describing their roles in knowledge sharing for collaborative innovation between SMEs and academia. This study explores how key individuals have enacted objects into being (Law and Singleton, 2005; Lindberg and Walter, 2013) in collaborative innovation projects, and how objects-in-use (Lindberg and Walter, 2013) facilitate knowledge flows between two of more knowledge bases.

A selected group of objects has been identified as reoccurring objects used in the multiple case studies of eight of collaborative innovation projects between SMEs and academic researchers – collaborations facilitated and supported by brokers. Five objects have been identified, and those are *Project Proposals, PowerPoints, Excel, Meeting places,* and an '*Object*' that is central to the collaboration. This latter object is the so-called 'boundary object' (Star and Griesemer, 1989; Carlile, 2002; Star, 2010), which need to be flexible enough to adapt to specific needs but robust enough to maintain a common identity across boundaries (Star and Griesemer, 1989). Boundary objects are objects that bridge over various types of boundaries, and thus they help actions of different groups to connect (Lindberg and Walter, 2013).

In this study, a descriptive classification of objects-in-use is developed based on the roles of the five objects identified in the projects. The classification, which is termed the "*four S' of objects-in-use,*" includes the four different types of objects: *structural objects, spatial objects, sparring objects,* and *situational objects*. These descriptive classifications of the objects 'signal' their role in practical terms – how they have been enacted into being in action.

The five objects are tested in a co-design workshop, where participants (*Case Alpha* and *Case Beta*) in the *Object Game*[31] are *story-building* (*figure 1*) which shapes the context for the five main objects, and *co-rating* of the five main objects in facilitating knowledge transfer, exchange, generation and integration (*figure 2*). The findings are presented in *table 1* in a later section.

Findings indicate that objects may not always be determined *ex ante* (before the object has been used), but mostly *ex post* (after the object has been used in a certain action or activity). This is evident with object that, at first, were predetermined to be one type of object (for instance, sparring object), but in practice the object was enacted into being another type (e.g., structural object). The difference is apparent in *Case Alpha* and *Case Beta*, where Excel in one case is enacted into being a *sparring object*, whereas in the other case, Excel is enacted into being a *structural object*. These findings indicate that one object may play different roles, depending on the context.

[31] For a description of game materials in the Object Game, please refer to the co-design workshop in *Chapter 6*.

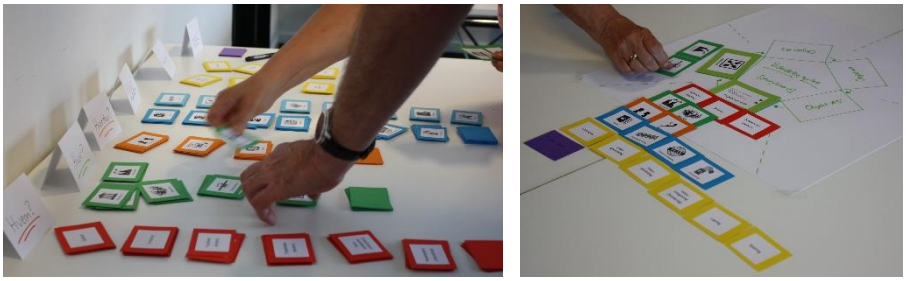

Figure 1. Storybuilding: Participant take cards from one table (left) and place on the 'storyboard' on another table (right).

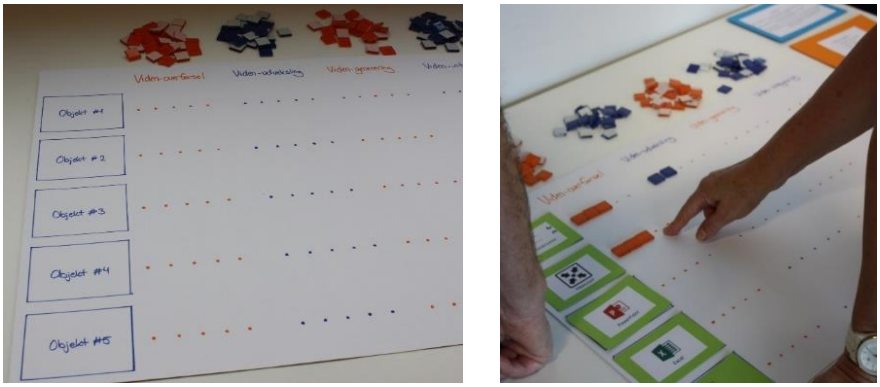

Figure 2. Co-rating of the five main objects according to the four types of knowledge flows (left) and co-rating in action (right).

2. Theoretical background

Knowledge flows in many ways and with different explicit or implicit purposes. In collaborative innovation projects, knowledge is shared between individuals to a certain extent with the use of objects. There are four modes of knowledge creation: socialization, externalization, combination, and internalization (Nonaka, 1994), which is also known as the SECI model of knowledge conversion (Nonaka and Takeuchi, 1995). The SECI model illudstrates socialization as converting tacit knowledge to tacit knowledge, externalization as converting tacit knowledge to explicit knowledge, combination as explicit knowledge to explicit knowledge, and internalization as explicit knowledge to tacit knowledge (Nonaka, 1994). Tacit

knowledge is rooted in action and involvement in specific contexts, whereas explicit knowledge is codified and can be articulated and transferred through certain objects, and this is where boundary objects are critical (Star and Griesemer, 1989; Nonaka, 1994; Bessant and Tidd, 2007; Conway and Steward, 2009).

To simplify the complexity of knowledge sharing in collaborative innovation projects, and to distinguish the different types of knowledge flows between many actors with different knowledge bases, four types of knowledge flows are defined[32]: *knowledge transfer, knowledge exchange, knowledge generation,* and *knowledge integration.*

1. *Knowledge transfer* is a one-way knowledge flow from one knowledge base to another. This is typically a flow of knowledge from academia to business.
2. *Knowledge exchange* is (at least) a two-way knowledge flow, an interchange, between two (or more) knowledge bases. Generally, knowledge is not created through an exchange.
3. *Knowledge generation* is the act of bringing into existence, the creation of, new context- and situation-specific knowledge. It is the transformation of existing knowledge.
4. *Knowledge integration* is the unification of, the act of absorbing, newly generated context- and situation-specific knowledge into existing or new operational tasks, processes, products, or services.

Objects play a role in facilitating different types of knowledge flows in projects that bridge knowledge bases or 'boundaries'. Boundaries are sociocultural differences leading to discontinuities in actions and interaction (Akkerman and Bakker, 2011a), and these "boundaries can be crossed by people, by objects and by interactions between actors of different practices" (Akkerman and Bakker, 2011b; 2). One concept that has been used in relation to boundary-crossing activities, coordination, and knowledge sharing is boundary objects (Lindberg and Walter, 2013). The term 'boundary objects' was introduced and defined by Star and Griesemer (1989) as objects that are

> "both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation" (Star and Griesemer, 1989; 393).

Objects that are enacted into being are 'objects-in-use', and these objects-in-use are not stable entities (Law and Singleton, 2005; Lindberg and Walter, 2013). Star argues

[32] Also presented in *chapter 3, section 3.1.2.*

that, "An object is something people act toward and with. Its materiality derives from action, not from the sense of prefabricated stuff or 'thing'-ness," (2010; 603). Futhermore, Zeiss and Groenewegen (2009) state that a boundary object is context dependent and "can be used to manage boundaries through facilitating the transformation of knowledge, some boundary objects are more effective in this than others, and boundary objects can be purposefully created" (p. 91). These objects can assist people to learn about differences across boundaries and to understand the interdependencies (Lindberg and Walter, 2013).

From an OMS-perspective (Organization and Management Studies), the interpretation of boundary objects as transforming knowledge is seen as useful attributes in management tools (Zeiss and Groenewegen, 2009). Carlile (2002) states that objects, models, and maps have the ability to transform knowledge, and objects that transform knowledge are the most effective boundary objects.

Nicolini et al. (2012) argues that boundary-spanning activities, including face-to-face meetings, are necessary to support the role of boundary objects in cross-disciplinary work. For transformation, real dialogue and collaboration between 'flesh-and-blood partners' at either side of the boundary is of great importance (Engeström et al., 1995, p. 333). Nicolini et al. (2012) classify the role of objects into a three-level hierarchy: *tertiary objects, secondary objects, and primary objects*. Tertiary objects are phones, email systems, physical spaces, project proposals and similar. Secondary objects can facilitate collaboration but does not trigger or fuel it, such as PowerPoints, shared analytical methods – most objects fall into the second category. Primary objects, according to Nicolini et al. (2012), have the capacity to explain *what* and *how* of the collaboration, and thus explain what motivates and fuels it (e.g., specific product or production process).

When analyzing the role of objects in cross-disciplinary collaboration, such as in collaborative innovation projects between SMEs and academic researchers, the question of *what* and *when* are crucial (Nicolini et al., 2012). A combination of objects that support knowledge sharing is needed in collaborative innovation project and similar boundary practices. The question is which objects, what are their roles, and how do the objects facilitate knowledge sharing between SME and academia?

3. Research methods

3.1. Data selection and data collection

The collaborative innovation projects selected are all part of a regional program (Central region of Denmark) – the *GNTV-program*[33] – with the objective to create growth in SMEs through knowledge-based collaborations with academic researchers. Each collaborative project is a "case study". In total 26 in-depth, semi-

[33] Please refer to the introduction and *chapter 4* for a description and illustrations of the GTNV-program.

structured interviews with key individuals have been conducted, and documents (project proposals, websites) have been analyzed for eight collaborative innovation projects.

Key individuals are CEOs, creative directors, project managers, project coordinators, employees, academic researchers, and independent third parties (external project managers and external facilitators). After the interviews with the key individuals from the first five cases conducted, interview protocol was revised to include more specific questions regarding what objects have been used and how (i.e., PowerPoints, Excel, blueprints, project proposal, project timelines, project management tools) in the last three cases. Interviews were conducted in 2011-2015, recorded and transcribed. For qualitative validity and reliability, data was collected from diverse individuals through interviews and documents (i.e., formal applications, company websites, registry on Danish companies), and was triangulated and examined for reoccurring elements based on converging data (Creswell, 2014; Maxwell, 2013).

To explore the combination of objects used in specific projects, a co-design workshop was facilitated in 2015, with two of the last three cases, to explore how the collaborators have used objects to share knowledge. This was done by developing an exploratory design game (e.g., Brandt, 2006; Brandt et al., 2008) with the specific purpose of data collection on previously found data in the eight cases. This is an alternative way to develop an understanding of role of objects in knowledge sharing. Other design game designers have experimented with exploratory design games (Brandt, 2006) including business models (Gudiksen et al, 2004; Gudiksen, 2015). This study includes findings from the co-design workshop with the use of the design game – *Object Game*[34]. The workshop was video and audio recorded, and visual images were taken for analysis and documentation purposes.

3.2. Data analysis

The descriptive classification of objects-in-use are based on the data collected and analyzed in all eight case studies. The definitions for the different types of objects enacted into being are presented in *table 1* in *section 4.1*. The second part of the analysis is from the co-design workshop, where key individuals from two collaborative innovation projects were asked to co-rate how the five selected objects have facilitated one or more types of knowledge flows.

Following a constructivist approach to qualitative research, within-in case analysis (Miles and Huberman, 1994) was conducted by making tables with qualitative data organized into themes, in order to ensure reliable approaches to conducting the content analysis (Creswell, 2014). Cross-case analysis was performed by contrasting

[34] The Object Game is presented in *chapter 6*. In *Appendx H*, there are several images of the items of the game.

data to identify unique and common patterns (Miles and Huberman, 1994), and research group discussions. Data indicated that the eight cases have undergone processes that were similar but also with variations regarding interaction patterns, place and time. Five main objects were identified in the case data: Project proposals, Meeting places, PowerPoint, Excel, and a Boundary object that was central to the collaboration. Definitions on the role of the objects-in-use is the contribution from this part of the analysis.

Workshop participants from two of the collaborative innovation projects were asked to *story-build* (*figure 1*) starting from one main object at a time, and *co-rate* (*figure 2*) the five objects in relation to which extent those objects facilitated one of more types of knowledge flows in their collaborative innovation projects. The four different types of knowledge flows are *knowledge transfer, knowledge exchange, knowledge generation,* and *knowledge integration*. The results from the co-rating part are presented in *table 2* and discussed in *section 4.2.* Finally, the findings and results from this study have external generalizability (Maxwell, 2013) as transferrable components may be applied to other situations for collaborative projects and the use of objects in knowledge sharing processes, as well as making the users aware of objects facilitating different types of knowledge flows in boundary practices.

4. Identifying objects and their role in collaborative innovation projects

Objects are inevitable part of every collaborative innovation projects. In the eight collaborative innovation project, each project had at least one boundary object that crossed the boundaries of the key individuals involved. This boundary object at heart of a collaborative project differs in its tangibility. What all the main boundary objects have in common, across the cases studies, is that it has the capacity to explain what triggers and fuels the collaboration (e.g., Nicolini et al., 2012). Other objects identified in the cases are *Project proposals, Meeting places, PowerPoints,* and *Excel*. Each object plays a role in the knowledge sharing process.

As all eight case studies are part of a Danish regional program (GTNV-program) and thus all projects started with a project proposal, e.g. a template in Word-document that had been filled out by the participating actors. This object assisted the key individuals to structure their project by aligning expectations, setting goals, identifying milestones, and coordinating tasks and activities. The *Project proposal*, as a formal application to the regional program, was enacted into being an object that functions as a common ground for two parties planning to solve a problem in the firm. The actors are using this object to structure the process, therefore a *structural object*.

The actors involved in the projects met *face-to-face* on a regular basis (*figures 3-7*), at the firm, at the university, or at a neutral location. Physical locations where individuals interact and engage in the act of socialization (e.g. Nonaka, 1994).

Physical locations, such as meeting rooms at the firm or universities, are enacted into being places that create temporary space for human interaction – for personal and face-to-face dialogue. Therefore, in this case, a *Meeting place* is enacted into being a *spatial object.*

PowerPoint contains information and knowledge on a given subject, and so does *Excel*, when used activity by the collaborators. Information and knowledge is transferred through presentations from one party to the other, and these may spark dialogue between the parties involved. PowerPoint-files or Excel-files are also sent back and forth from one party to the other, and through this exchange of information – for instance questions and answers on PowerPoint slides or test result in Excel spreadsheets – it has the potential to create (new) knowledge. This object is most often a mean to an end and enacted into being a tool for a two-way communication, a sparring between two parties, and therefore a *sparring object.*

As mentioned previously, each project has a *boundary object* at heart, and this boundary object is the reason *why* the two or more parties collaborate. This particular object is context dependent and can be the mean to an end or an end in itself. Boundary objects of this type have the potential to be enacted into being a 'sponge' that absorbs the knowledge produced between the key individuals, with potential to be integrated into existing activities, or to create new activities. This type of object depends on its use in a specific context or situational, therefore object-in-use is termed a *situational object.*

4.1. Defining the the four types of objects-in-use

The four types of objects-in-use – *structural, spatial, sparring,* and *situational* – are objects that have been enacted into being and therefore play a certain role in knowledge sharing processes. Objects in the eight projects have played a role, and this role is underscored in the descriptive classification of objects-in-use. Findings indicate that this 'role' needs to be stated after the fact – in retrospection. If an object is one type or the other depends on the context in which it has been used. Hence, one should be careful to state that for instance *all* Project proposals are structural objects, or that PowerPoints are *always* sparring objects. However, some objects have the tendency to be enacted into being the same type of object-in-use. The descriptors of structural, spatial, sparring, and situational are *ex post* and not *ex ante*. The descriptive classification is the *four S' of objects-in-use. Table 1* outlines the definitions of the four types of objects-in-use.

Table 1. The four S' of objects-in-use: definitions of the four types of objects.

Types of Objects-in-use	Definition	Examples
Structural object	An object that is enacted into being a framework, a common ground uniting two or more actors, aligning expectations, setting goals, identifying milestones, and coordinating tasks and activities.	Project proposals Contracts Formal applications
Spatial object	An object that is enacted into being a shared place that creates temporary space for face-to-face interaction, a common playing field for boundary-crossing activities and goal-specific tasks.	Physical locations Meeting rooms Conference rooms supported by technology
Sparring object	An object that is enacted into being a mean to an end supporting interpersonal communication, knowledge transfer or exchange, and has the potential to capture knowledge generated through interaction.	Physical objects IT-based objects PowerPoints Excel Drawings Models Blueprints
Situational object	An object at the center of a collaborative project and is enacted into being an end in itself, or a mean to an end, supporting the generation of new context- and situation-specific knowledge and the integration thereof into existing or new activities.	Tangible material Intangible materials Products Services Processes

In order to explore the roles further, and the combination of objects used in specific collaborative projects, a co-design workshop was conducted with two of the cases – *Case Alpha* and *Case Beta.* The workshop was facilitated to explore how the collaborators have used objects in their collaborative innovation projects, how the five main objects have been enacted into being, and how the collaborators experienced these objects in relation to facilitating the four types of knowledge flows (i.e., transfer, exchange, generation, and integration). The five objects are incorporated into a design game developed for this specific purpose – *the Object Game* – a board game with game pieces and focuses on building a story through objects, as well as to rate objects in relation to the types of knowledge flows.

4.2. Objects facilitating different knowledge flows in Case Alpha and Case Beta

The role of objects is context dependent, as each object's purpose is determined by how it has been enacted into being (e.g., Law and Singleton, 2005; Lindberg and Walter, 2013). The combinative use of objects may shed light on how objects facilitate knowledge sharing in collaborative innovation projects, and results from the *Object Game* with the collaborators in *Case Alpha* and *Case Beta* are illustrated in *figures 3-7*[35]. These images are from the *story-building* part of the Object Game and show the 'story' that tells us the context in which the five main objects have been used in practice.

Furthermore, *Case Alpha* and *Case Beta* rated, on a scale from zero to five, each of the five main objects in relation to which degree the particular object facilitated knowledge transfer, knowledge exchange, knowledge generation, and knowledge integration in their respective projects. *Table 2* shows the results of how Case Alpha and Case Beta have rated the five main objects in the *co-rating of objects* part of the Object Game.

Table 2. Results from Co-rating the five main objects in relation to the four types of knowledge flows in knowledge sharing processes.

Objects *(Objects-in-use)*	*Case (type of innovation)*	*Type of knowledge flow*			
		Knowledge transfer	**Knowledge exchange**	**Knowledge generation**	**Knowledge integration**
Project Proposal *(Structural object)*	*Alpha (process)*	***	**	-	-
	Beta (service)	***	**	-	-
Meeting places *(Spatial object)*	*Alpha (process)*	****	****	****	****
	Beta (service)	*	***	*****	-
PowerPoint *(Sparring object)*	*Alpha (process)*	*****	*	**	**
	Beta (service)	****	****	***	*****
Excel *(Sparring object)*	*Alpha (process)*	**	*****	****	****
	Beta (service)	***	-	-	-
Boundary object *(Situational object)*	*Alpha (process)*	*	**	*****	*****
	Beta (service)	-	***	*****	*****

Case Alpha: Process innovation. Case Beta: Service innovation.

Scale for rating of objects: 0 = not relevant. 1 = very low degree. 2 = low degree.
3 = some degree. 4 = high degree. 5 = very high degree.

[35] A list with the story-cards and translation to English is avalaible in *Appendix I*.

Figure 3. Results for main object: Object of own choice (boundary object).
Case Alpha with process innovation (top) and Case Beta with service innovation (below)

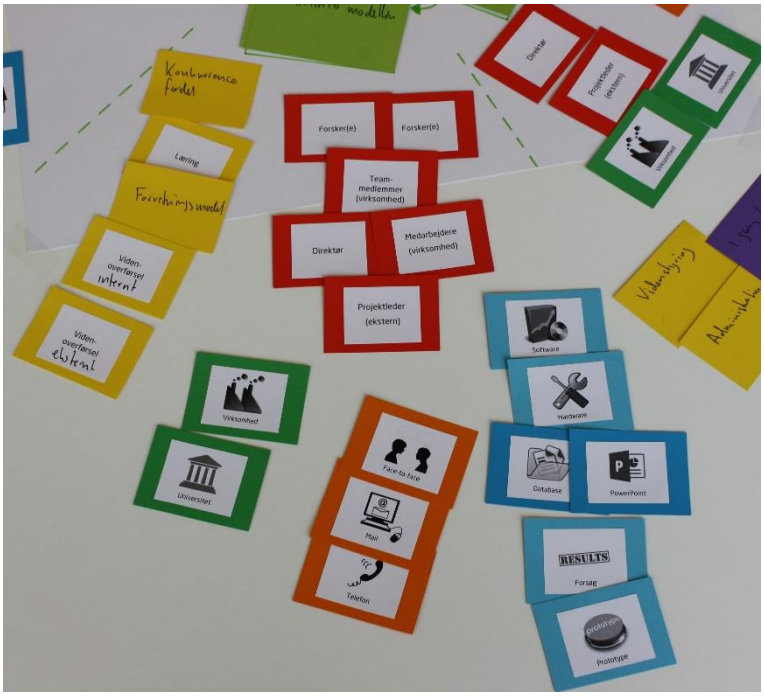

Figure 4. Results for main object: Project proposal.
Case Alpha with process innovation (top) and Case Beta with service innovation (below)

Figure 5. Results for main object: Meeting place.
Case Alpha with process innovation (top) and Case Beta with service innovation (below)

Figure 6. Results for main object: Powerpoint.
Case Alpha with process innovation (top) and Case Beta with service innovation (below)

Figure 7. Results for main object: Excel.
Case Alpha with process innovation (top) and Case Beta with service innovation (below)

The main *boundary object* in each case, respectively, facilitated to a very high degree the generation and integration of knowledge, as well as some knowledge exchange (*figure 3* and *table 2*). This object assisted the collaborators to create context- and situation-specific knowledge and then integrate it into the firm – either as changes in the production process of products (Case Alpha) or as new service model to change the way products are created (Case Beta).

Project proposals assisted the collaboration by facilitating knowledge transfer (some degree) and knowledge exchange (low degree) (*figure 4* and *table 2*). During planning, alignment of expectations, and goal setting, each actor transfers some knowledge via the project proposal. In the process of writing the proposal, an exchange of knowledge occurs, as well. According to the *story-building* in *figure 4*, this project proposal was primarily developed *face-to-face* (i.e., the first orange card in both images).

There are some variations in how *meeting places* have facilitated knowledge sharing via different types of knowledge flows (*table 2*). The differences could be explained by context. *Case Alpha* is a manufacturing firm and the goal of the collaborative project is to make significant changes to the production process. The actors often met at the production line where the changes ultimately needed to be implemented (*figure 5, top image*). On the other hand, *Case Beta* is a service firm with the goal of developing a new model for significant changes in their core-services. The actors met in conference rooms to develop the key elements of the model, and change could only be implemented while servicing clients (*figure 5, bottom image*). Hence, the meeting place facilitated all types of knowledge sharing in Case Alpha, but primarily knowledge generation and exchange in Case Beta, according to their co-rating in *table 2*.

The use of *PowerPoint* differs in the two cases, and hence the facilitation of knowledge flows differs (*figure 6* and *table 2*). Case Beta enacted PowerPoint into being a *sparring object* that facilitated all types but primarily knowledge integration – knowledge was stored in PowerPoints. Case Alpha, on the other hand, used PowerPoints to transfer knowledge from the academic researcher to the firm – predominantly one-way flow of knowledge and facilitating only a low degree of exchange, generation, and integration.

However, the greatest difference in use of object is with *Excel* (*figure 7* and *table 2*). Excel was enacted into being a *sparring object* in Case Alpha (process innovation), which facilitated a great degree of knowledge exchange, generation, and integration. It was primarily used by the researchers at the University for process and test results, but it was also used for keeping track of time spent on activities in the project (*figure 7, top image*). On the other hand, Case Beta (service innovation), used Excel as a *structural object*, thus a reporting tool for project management used by the director and project manager, which was sent by e-mail (*figure 7, bottom image*). Excel used by Case Beta facilitated one-way flow of knowledge, or more likely information.

This example in *figure 7* and co-rating in *table 2* pinpoints that it is very difficult to predetermine the role of object *ex ante*, without knowing the context and how it will be used. Therefore, the descriptive classification should be used with caution, as not all for instance Excel spreedsheets are used as, or enacted into being, sparring objects that facilitate various types of knowledge flows, but may only be used as a structural object facilitating merely, in this case, a one-way flow of information.

As *figures 3-7* illustrate, the primary method of interaction in Case Alpha and Case Beta was *face-to-face*. Both cases also rated spatial objects (meeting places) as facilitating knowledge generation in their respective projects; this indicates a high degree of interaction between the collaborators with the intent of generating knowledge for (possible) significant changes to be made. These changes can be implemented by integrating the situational object into operational activities – and sparring objects assist this integration.

Case Alpha and Case Beta both indicate that the primary meeting place was at the firm (*figure 5*). This suggests that the knowledge sharing processes predominantly occurred at the firm, face-to-face, close to the destination location of the knowledge shared and created in the process. This process combined different types of objects, including the boundary object that is the situational object ('object of own choice' in the Object Game), combined with sparring objects (Excel or Powerpoint), spatial objects (meeting place), and guided to some extent by the structural object (project proposal).

5. Discussions

The understanding of the role of objects in knowledge sharing is essential in innovation projects between collaborators from different boundaries and knowledge bases. This study explores how SMEs and academic researchers use objects in collaborative innovation projects to transfer, exchange, generate, and integrate knowledge. To be noted is that objects as stable entities do not carry or share knowledge themselves, it is the people's interaction with the objects that enact them into being, thus objects-in-use (Law and Singleton, 2005; Lindberg and Walter, 2013).

The descriptive classification of objects-in-use (*ex post*) includes, from this analysis, four types: *structural objects, spatial objects, sparring objects,* and *situational objects*. This classification is the *"four S' of objects-in-use"*, and the purpose of this classification is to give meaning to objects as one particular object is enacted into being a certain type of object playing a specific role. One objects may facilitate one or more types of knowledge flows – *knowledge transfer, exchange, generation, and integration*. The latter, knowledge integration, is the act of exploiting new knowledge created between the two knowledge bases, and may be argued to be the most important type of knowledge flow for collaborative innovation.

Carlile (2002) perceives the most effective boundary objects as those objects that transform knowledge. Objects that support creation of new knowledge, and the integration thereof, transform existing knowledge from different knowledge bases. Those objects are, according to this study and classification, predominantly *situational objects*. However, this particular object-in-use cannot stand isolated without the use of other object categories, as is evident in *figures 3-7*.

In the four S' of objects-in-use classification, the primary boundary object is the *situational object*. This object is the one that motivates and fuels the collaboration (e.g. Nicolini et al., 2012). Objects-in-use that complement situational objects, such as *sparring objects* and *spatial objects* are also boundary objects, since those objects answer the *how* of a collaboration. Hence, the use of objects is highly dependent on the agreement between the actors involved, and thus which role the particular object should (and will) play in a specific context. In the findings, we can see that one object can be enacted into two or more types of objects-in-use, depending on intentions (*why*), usage (*how*), timing (*when*), and context (*where*). Therefore, we should be cautious not to classify objects *ex ante*, without knowing the context and specific use, as objects are enacted into being and therefore their role is determined *ex post*.

Discussing the four S' of objects-in-use classification in relation the SECI model (Nonaka, 1994; Nonaka and Takeuchi, 1995) – socialization, externalization, combination, and internalization – may shed light on how the four types of objects facilitate different knowledge conversions. In theory, the combinative use of the objects identified in this study facilitate the four modes of knowledge conversion. Arguably, *situational objects* facilitate *combination* where different sources of explicit knowledge are pooled and exchanged (explicit to explicit) and internalization (explicit to tacit) of knowledge, in addition to the two types of knowledge flows of *knowledge generation* and *knowledge integration*. It is difficult to state how each type of object-in-use facilitate the four modes, and this may be subject to further research.

Theoretically, *spatial objects* facilitate 'socialization' (tacit to tacit) through face-to-face interaction, and in combination with *sparring objecs*, the two types of objects facilitate 'externalization' (tacit to explicit). When *spatial objects* and *sparring objects* are enacted in combination with *situational objects* (boundary objects), then the combinative use of objects also facilitate 'combination' (explicit to explicit), and in some instances 'internalization' (explicit to tacit). *Structural objects* may guide the process in which the four modes may be achieved, if actors in the collaborative innovation projects are aware of the combinative use and roles of objects in knowledge sharing processes.

There are some limitations to this study. First, the descriptive classification of objects-in-use is merely 'descriptive' of what roles the objects are enacted into playing in the certain context – and can only be determined after the particular objects has been used in action. It would be interesting to study collaborative

innovation projects, in for instance other programs, to identify if the same type of objects are present, and to investigate whether the objects are enacted into facilitating knowledge flows in similar ways as in this study. Second, in this study a workshop was conducted with two cases, each with a different focus, service innovation and process innovation, respectively. Investigating groups of cases with the same focus, and thereafter comparing and contrasting findings, would arguably strengthen the normative implications of how objects facilitate different types of knowledge flows between two or more knowledge bases.

Therefore, further investigation is needed in order to gain a profound understanding of the role of objects-in-use in knowledge sharing processes between SMEs and academia (e.g., between actors with different knowledge bases), and how the four S' of objects-in-use classification can be used proactivelty in practice. Suggestions for further research include the identification of candidates for objects playing the roles of structural, spatial, sparring, and situational objects in collaborative projects and other collaborative boundary practices between actors from different boundaries. Investigating multiple cases and identifying objects that play these roles (and other roles) could potentially assemble an array of object candidates for collaborators to choose from in their projects with external actors. The identification of possible candidates to be enacted into one of the four types of objects-in-use would be useful information on objects that have the potential – in a given context and situation – to transform knowledge between different knowledge bases.

6. Conclusions and implications

Insights from this study with the development of the *four S' of objects-in-use classification*, and the testing of objects in relation to the four types of knowledge flows – *transfer, exchange, generation, integration* – are valuable for actors engaging in collaborative innovation projects, as well as for researchers in the field of boundary objects.

The managerial implications of this study is especially of interest and value to project managers and CEOs in SMEs who engage in collaborative projects with external partners. The awareness and understanding of the role of objects, the combinative use of objects, and how these objects facilitate different knowledge flows between different actors, is important when designing collaboration processes across boundaries. Knowledge sharing as a combination of objects, people, and processes for is a complex puzzle that needs further research in order to assemble a 'toolbox' with possible candidates of – *structural, spatial, sparring, situational* – objects to be used actively by practitioners for effective knowledge flows in collaborative boundary practices.

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A special thanks to design game designer and co-facilitator, Hanne Lindegaard, for your collaboration on developing the Object Game and co-facilitating the workshop. Without your help and without the participation of key individuals from the collaborative innovation projects, the findings in this article would not have existed today. Thank you for your curiosity and open-mindedness.

Bridge to *PART IV. HOW DO SMEs COLLABORATE WITH ACADEMIA?*

Chapter 7 concludes the empirical research part of the PhD dissertation. This chapter explores the role of objects in collaborative innovation projects, defining the different types of objects, and with the Object Game, testing how these objects facilitate different types of knowledge flows.

This leads to interesting findings, not only to the subject being 'the role of objects', but also the process of developing the Object Game (*chapter 6*), which brings valuable insights about the field of design games as boundary objects in workshop settings – both for research purposes and for collaborative reflections. A tool that can be used in other contexts where actors from different boundaries engage in boundary-crossing activities for collaborative purposes.

Part IV summarizes the findings from the empirical research – *chapters 4, 5, 6,* and *7* – and discusses the contributions to theory, practice, and policy. *Chapter 8* also shapes and defines *collaborative boundary practices* and highlights how these can guide the practices in contexts where various actors with different knowledge bases interact and collaborate through projects.

PART IV.

HOW DO SMEs COLLABORATE WITH ACADEMIA?

Chapter 8. Conclusion and key takeaways

Part I introduces collaborative innovation in Denmark with an empirical overview and policies as instruments for collaborations between SMEs and knowledge actors, including Academia. Statistics show that only *15.6 percent* of innovation SMEs collaborate with external knowledge actors, thus *84.4 percent* have no collaboration[36]. *7.98 percent* of innovation SMEs collaborate with Universities and Higher educational institutions[37], whereas *32.7 percent* of innovation SMEs claim to be organizational innovative by introducing the new organizational method, "external relations"[38]. SMEs opening up and collaborating with academia is an act of organizational innovation.

The findings from this PhD dissertation can help more SMEs to overcome the some of the classical barriers that firms face when collaborating with academia and other knowledge actors. Thus, more SMEs can become organizational innovative by integrating academic knowledge into their products, services, and processes, and thereby become 'all-round' innovative SMEs. Developing policy instruments with the *right* built-in mechanisms will arguably create the conditions where SMEs not only collaborate with Academia but the knowledge flows will ultimately lead a great impact on economic growth and society.

However, innovation politicies can only do so much; practitioners such as 'brokers' (consultants and 'bridge-building people') need to understand how actors from different boundaries can collaborate through various types of mechanisms. This is *why* studying mechanisms that help SMEs engage in external relations and organizational innovation is important. There are many mechanisms for this; in this PhD study, the mechanism is collaborative innovation projects.

To get a feeling for what collaborative innovation projects are, more than *projects* (activities in a limited time) for *collaborative innovation* (potential outcome that may primarily have an impact of the firm), five themes were identified and discussed by collaborators, and summarized into key points[39]. These five themes are *Knowledge-based collaboration, Chemistry, Dialogue & interaction, Knoweldge,* and *Innovation.* The key points communicate how the collaborators have experienced and perceived these themes in the context of collaborative innovation projects. Hence, collaborative innovation projects is the mechanism studied between SMEs and Academia in order to explore *how* they collaborate (from a process-perspective).

It may be argued that collaborative innovation projects are *micro-level* mechanisms facilitated by micro-level brokers, *brokers of human interaction*; whereas, the GTNV-

[36] *Chapter 1, Section 1.2, figure 1.2.*
[37] *Chapter 1, Section 1.2, figure 1.4.*
[38] *Chapter 1, Section 1.2, figure 1.1.*
[39] *Chapter 1, Section 1.5, table 1.1.*

program is a *meta-level* mechanism coordinated by *meta-level* brokers (e.g., knowledge brokers). The combination of the micro- and meta-level mechanisms – as an *integrative* mechanism – essentially mitigates the gap betweem the world of businesses and the world of academia. This is a gap constituting of human-based barriers and system-based barriers[40].The section introduces the empirical lens – GTNV-program – with both a conceptual framework (*figure 1.5*) and empirical model (*figure 1.6*).

Moreover, to understand the mechanisms researched empirically, the literature review in *Part II* gives a theoretical understanding and foundations for exploring some of the aspects of these mechanisms: brokers, capabilities, and objects. These are interconnected in the *integrative mechanism*, as are many other concepts and focus areas. Nonetheless, the empirical research with the focus on exploring the roles of brokers, capabilities, and objects, help us understand how this type of mechanism aids an SME in their quest for new knowledge, strategic change, and innovation.

The PhD study researches collaborative innovation projects between SMEs and Academia, and the empirical research in *Part III* is based on multiple case studies – of eight collaborative innovation projects. Each of the chapters include discussions on the findings of the study in the particular chapter. *Table 8.1* provides as very condensed summary as 'key takeaways' from the empirical research in *chapters 4-7*. These key takeaways and findings in the empirical research provide us with knowledge to shape 'collaborative boundary practices'.

8.1. Shaping *collaborative boundary practices*

Studying the mechanism of collaborative innovation projects in the empirical setting (GTNV-program) through the theoretical lens – roles of brokers, capabilities, and objects – shapes the *collaborative boundary practices*[41] that can be transferred and applied in other contexts, where various actors from different boundaries engage in projects.

The set of activities and actions taken in collaborative boundary practices can lead to (strategic) change and innovation – in firms and other actors. These practices are characterized by coordinated and synchronous boundary-crossing activities in a process of shared creation and shared meaning about a given boundary object – the *situational object*. These activities are coordinated and facilitated by two types of brokers – meta-level and micro-level brokers. The latter is a broker of human interaction, which arguably need to focus on the *interaction enablers* found in *chapter 4*.

[40] Briefly introduced in *section 1.4* of *chapter 1* and discussed in *chapter 3, subsection 3.2.2.*
[41] *Please refer to chapter 3, figure 3.1.*

Table 8.1. Key takeaways from the empirical research

Empirical research	Key takeaways
Chapter 4	▪ Elements of the collaborative innovation projects: interaction enablers, collaboration characteristics, main drivers, and main barriers *(table 2, chapter 4)* ▪ Two types of brokers – micro-level and meta-level ▪ Defining *broker of human interaction* (micro-level broker) ▪ Gap between the two worlds is mitigate by the structured and formalized interactions facilitated by the two types of brokers ▪ Time is potentially the greatest barrier to collaborative innovation – SMEs and external actors need to prioritize it
Chapter 5	▪ Engaging in collaborative innovation projects help build the microfoundations of dynamic capabilities in SMEs ▪ A process model of dynamic capabilities for knowledge sharing in collaborative innovation projects *(figure 2, chapter 5)* ▪ Illustration of knowledge generation, integration, and hibernation *(figure 3, chapter 5)*
Chapter 6	▪ The *Object Game* – an exploratory design game as a boundary object and enacted as a sparring object in co-design workshop ▪ Developing a research tool and reflective tool – for dialogue and reflection on collaborative innovation projects ▪ Facilitating dialogue different than a usual conversation between collaborators, and different than in a qualitative interview between research and interviewee ▪ Envisioning the *Co-alignment game* – a future-oriented design game playing with possible futures (*table 1, chapter 6*)
Chapter 7	▪ Using the Object Game to explore the role of objects in collaborative innovation projects ▪ Developing the descriptive classification: *4 S' of objects-in-use* ▪ Defining structural objects, spatial objects, sparring objects, and situational objects *(table 1, chapter 7)* ▪ Creating an awareness for using objects to facilitate knowledge flows

Interaction enablers refer to elements that enhance or make interaction between different actors possible. Many of these are also mentioned in the key points addressed in *chapter 1* (*section 1.5*). Other elements of collaborative innovation projects are categorized into collaboration characteristics, drivers and (potential) barriers (*chapter 4, table 2*).

When investigating successful collaborative innovation projects, and exploring what makes them successful (other than completing the GTNV-program), it is essential to focus on the main drivers of such collaborations. These main drivers include strategic alignment in the firm, leadership involvement, willingness (of the firm) to change, and engaging the internal project team to anchor new knowledge created into operational activities.

However, collaborations also pose potential barriers, and perhaps the greatest barriers to collaborative innovation is the factor of time. In other words, reallocating time from operational activities (exploitation) to innovation activities (exploration), to create new knowledge through projects, which then can be integrated and exploited in (new) operational activities, is an important 'practice' in itself.

In *chapter 5*, we learn that firms build microfoundations of dynamic capabilities and relational capabilities by engaging in collaborative innovation projects. This is not directly observed empirically, but the conceptual discussion in *chapter 5* draws parallels between dynamic capabilities and key concepts in innovation and knowledge management. SMEs develop their ability to effectuate strategic change, in order to stay or become competitive, by collaborating with this type of external knowledge actors; if this holds true in practice, this is a very compelling argument for SMEs to engage in collaborative projects with external knowledge actors and other open innovation processes.

Collaborative boundary practices is all about creating channels for knowledge to cross boundaries – with the help of brokers and objects – and applying mechanisms that encompass and facilitate knowledge flows. Through these channels and knowledge flows, knowledge transformation occurs as existing knowledge from two or more boundaries is transformed into context- and situation-specific knowledge, which is to be integrated by one or more of the actors.

The study on the role of objects (*chapters 6* and *7*) shows how certain objects facilitate knowledge flows in collaborative innovation projects, and how the development and application of an exploratory design game – the *Object Game* – works as a boundary object in a workshop setting. The Object Game is thus a sparring object, according to the descriptive classification, *4 S' of objects-in-use* (definitions in *chapter 7, table 1*).

The Object Game is exploring 'as-is' practices and the world as it is, and hence is retrospective. Such an exploratory design game is valuable in 'closing the loop' between actors in any given project. Collaborators engage in a dialogue, facilitated

by actively using the game pieces, which is beneficial in reflecting on their collaboration: what went well, and what can be done better or differently next time.

Chapter 6 also looks ahead at a future-oriented design game following the design thinking approach – *What is? What if? What wows? What works?* – to envision a *Co-alignment game* (*table 1*) that could be used in the beginning of (new) collaborative boundary practices. The function of this type of design game is to play with 'possible futures', align expectations between the actors, and thus shape the collaborative boundary practice by identifying different objects that may be enacted into being one or more of the objects in the 4 S' classification: structural, spatial, sparring, and situational. In sum, it is about finding the purpose and meaning of the collaboration, while designing an (effective) collaboration process to come.

The combinative use of the *Co-alignment game* and the *Object Game* can be perceived as a 'lifecycle of objects' in collaborative boundary practices that can be enacted into being *sparring objects.* The *Co-aligment game* to be used at the beginning of the collaboration in order to give meaning to the process and align expectations between the different actors; and as such, to be enacted into being a structural object, as well. The *Object Game* to be used for rounding off and signaling the completion of a given process, where the collaborators can learn from their own actions and lay the ground for an improved future collaboration process.

As the empirical research and the findings indicate, collaborative boundary practices are essentially a complex puzzle with many different combinations and alignments of people, processes, and objects, in order to make knowledge flow between knowledge bases and across boundaries.

8.2. Concluding answers to research questions

How do SMEs collaborate with Academia? is the central question studied in the PhD dissertation through the mechanism of collaborative innovation projects facilitated by two types of brokers in a formalized and structured regional program. The key assumption is that combining the knowledge bases of firms and academia will lead to a positive *outcome*, with a potential *impact* on the firm, and this is *why* the PhD study addresses the collaboration between SMEs and Academia. The *how* is studied from a process-perspective, and the scope is narrowed by focusing on exploring the roles of brokers, capabilities, and objects in the innovation and boundary-crossing activities in the collaborative innovation projects.

The central research question is broad and empirically grounded, and the three sub-questions narrow the focus of the PhD study:

- ***How does collaborative innovation take place between SMEs and Academia, and how do they combine their knowledge bases?***
- ***What is the role of brokers in collaborative innovation projects?***
- ***What types of objects facilitate the knowledge sharing process – and how?***

The empirical research focuses on these three sub-questions. The first and second sub-question is studied in *chapters 4* and *5*, and the third sub-question is researched in *chapters 6* and *7.*

From a process-perspective, 'collaborative innovation' takes place through projects that are formed by the elements identified and categorized as interaction enablers, collaboration characteristics, drivers, and barriers. These elements and the processes coordinated and facilitated by two types of brokers are what it takes, in this context, for SMEs and Academia to combine their knowledge bases. The GTNV-program is the structure that makes this happen.

This also answers the second sub-question – what is the role of brokers in collaborative innovation projects? – which is to make collaborative innovation happen through the mechanism of projects at micro-level and phase-based process at meta-level. The two types of brokers each have their role in making knowledge flow between SMEs and academic researchers, and thus make collaborative innovation take place. The knowledge brokers at meta-level coordinate the phase-based process in the GTNV-program and thereby facilitating the process of knowledge brokering.

The *broker of human interaction* facilitates the process at micro-level and ensures a dialogue-based process, face-to-face interaction and conversation, with a specific purpose. The role of this type of broker is in practice context-specific, and hence

depends on the needs of the firm; this is the strength of this type of broker. Sometimes the broker acts as a project manager, and in other instances, the broker facilitates the process first hand, such that the firm (explicitly) integrates the knowledge generated in the innovation process into operational tasks and daily activities. Overall, the broker of human interaction assists the SME with building relational capabilities with academic researchers.

From a capabilities view, SMEs engaging in collaborative innovation processes, as facilitated by the GTNV-program, build microfoundations of dynamic capabilities – especially sensing and seizing capabilities – and relational capabilities. The definition of dynamic capabilities applied in the research is "the capacity of an organization to purposefully create, extend, or modify its resource base" (Helfat et al., 2007; 4), and dynamic capabilities can for analytical purposes be disaggregated into sensing, seizing, and transforming capabilities. Additionally, relational capabilities can be viewed as dynamic capabilities, and is the capacity to include resources of external actors into the firms resource base (Helfat et al., 2007).

According to Helfat et al. (2007), a firm can *create* a resource base, or portions of it, through different types of resource creation activities, through for example innovation and entrepreneurial activity. A firm can also *extend* its current resource base in the direction of more of the same; an example is, when a firm seeks to promote growth in an ongoing business (Helfat et al., 2007). Additionally, firms can *modify* its resource base in order to change its business, for instance through responding to changes in the external environment (Helfat et al., 2007). Hence, SMEs learn to create, extend, or modify their (knowledge) resource base by including knowledge from external knowledge sources, as facilitated in the GTNV-program. Which form (i.e., create, extend, modify) it takes, depends on the content and aim (boundary object) of the collaborative innovation project.

The role of brokers is to assist the SMEs in building relational capabilities, and arguably, the role of the processes in the collaborative innovation projecs is to build sensing and seizing capabilities in SMEs. The SME, with its top manager as an active participator in the project, gains an insight into a different world – the world of academia – and develops the ability to search for knowledge sources outside their industry and business ecosystem. This is a shift of focus towards collaborating with different types of partners, and an attempt to transform by including external resources into the firm's resource (knowledge) base. In addition, this will eventually lead to firms building the capacity to effectuate strategic change by including resources from external knowledge sources. In sum, SMEs and Academia combine their knowledge bases with the assistance of the two types of brokers and the structure of the GTNV-program.

Moreover, answering the third sub-question also partly answers how SMEs and Academia combine their knowledge bases in collaborative innovation projects. Objects play a role in facilitating different types of knowledge flows, which is studied in *chapter 7*. Hence, if objects facilitate knowledge flows in these knowledge sharing

processes, then these findings also answer how SMEs and Academia combine their knowledge bases.

As *chapter 6* and *7* discuss, there are five main objects (meta-objects) identified being used in the multiple case studies (eight collaborative innovation projects): *Project proposals, PowerPoint, Excel, Meeting places*, and *an Object* at the center of the collaboration – the boundary object. These objects are integrated in the exploratory design game – the *Object Game* – and *chapter 6* describes the designing and developing process, as well as its use in action. The Object Game with its two parts – *Story-building* and *Co-rating of objects* – is shown in action in a co-design workshop (*chapter 6*). This research tool (and reflective tool) helps explore the role of objects in collaborative innovation projects, and explore how these objects facilitate different types of knowledge flows in knowledge sharing processes. The types of knowledge flows are *transfer, exchange, generation,* and *integration.*

The descriptive classification of the different types of objects signals the 'roles' of the main objects identified in the multiple case studies: *four S' of object-in-use* (*4 S'*). These are *structural objects, spatial objects, sparring objects,* and *situational objects*, and are defined in *chapter 7.* According to the 4 S', the Object Game is enacted into being a sparring object in the co-design workshop.

When comparing the role of objects in collaborative innovation project with the SECI model (Nonaka, 1994; Nonaka and Takeuchi, 1995), theoretically, *spatial objects* facilitate 'socialization' (tacit to tacit) through face-to-face interaction, and in combination with *sparring objecs*, the two types of objects facilitate 'externalization' (tacit to explicit). When *spatial objects* and *sparring objects* are enacted in combination with *situational objects* (boundary objects), then the combinative use of objects also facilitate 'combination' (explicit to explicit), and in some instances 'internalization' (explicit to tacit). *Structural objects* may guide the process in which the four modes may be achieved, if actors in the collaborative innovation projects are aware of the combinative use and roles of objects in knowledge sharing processes.

Nevertheless, the use of objects is highly dependent on the agreement between the actors involved, and thus which role the particular object should (and will) play in a specific context. *A situational object* is the primary boundary object, which has the capacity to explain what motivates and fuels the collaboration (e.g. Nicolini et al., 2012). Objects-in-use that complement situational objects, such as *sparring objects* and *spatial objects* are also boundary objects, since those objects answer the *how* of a collaboration. Hence, one particular object can be enacted into two or more types of objects-in-use, depending on intentions (*why*), usage (*how*), timing (*when*), and context (*where*). In using the 4 S' of objects-in-use classification, one should be cautious not to classify objects *ex ante* (before enactment), without knowing the context and specific use, as objects are enacted into being and therefore their role is determined *ex post*.

The three sub-questions underscores that the *outcome* (collaborative innovation) of these types of collaborations between SMEs and Academia is a complex process based on many components, including the roles of the people involved, activities, and the various objects. The potential *impact* on the firm is essentially based on the firm's and its manager's ability to integrate this new knowledge into existing or new activities in the firm. This potential *impact* calls for a bundle of capabilities in the firm: *absorptive capacity, dynamic (managerial) capabilities, relational capabilities,* and *innovation capabilities.* This bundle of capabilities can be termed *collaborative innovation capabilities* and are essential for the continuous innovation in firms – ultimately leading to survival or growth.

8.3. Academic contributions and suggestions for further research

This PhD dissertation contributes to bodies of literatures within innovation management, strategic management, and knowledge management. Overall, the PhD dissertation links the literatures on knowledge brokers, dynamic capabilities and boundary objects, and their roles in collaborative innovation projects, through the empirical lens – GTNV-program.

The findings from exploring the role of brokers in the empirical setting, GTNV-program, contributes to the brokerage theories of innovation, role of knowledge brokers, recombinant innovation (Hargadon, 1998, 2002, 2003, 2014), and innovation intermediaries (Howells, 2006). Describing the two types of brokers acting at meta-level and micro-level contributes with empirical evidence on the role of brokers in facilitating collaborative innovation projects within a formalized structure. The GTNV-model for facilitating interactions (the regional GTNV-program) includes what Davenport et al. (1999) calls stages for initial contact, testing, and main project; it is a framework for channeling knowledge flows between SMEs and Academia.

From a capabilities view, the empirical research contributes to the literature on strategic management by conceptually discussing how SMEs build microfoundations of dynamic capabilities (e.g., Helfat et al., 2007; Teece, 2007; Abell et al., 2008; Felin and Foss, 2009; Helfat and Peteraf, 2015) by engaging in collaborative innovation projects, as facilitated in the GTNV-program. Capabilities of sensing and seizing are being built, and the *broker of human interaction* assists the development of relational capabilities. Managers who are actively engaged in collaborative projects are building their abilities to sense, seize, and transform the firm's resource base.

Therefore, collaborative innovation projects can also be viewed as formal mechanisms for knowledge integration (e.g., Grant, 1996a; Grant, 1996b; Bengtsson et al., 2015;) and as learning mechanisms for the managers to build and deploy dynamic managerial capabilities for recombinant innovation (e.g., Hargadon, 2003) and continuous innovation in the firm (e.g., Boer and Gertsen, 2003; Boer and Bessant, 2004).

Studying the role of objects in collaborative innovation projects and developing a descriptive classification of the *four S' of object-in-use* contributes the literature on boundary objects (Star and Griesemer, 1989; Carlile, 2002, 2004; Zeiss and Groenewegen, 2009; Nicolini et al., 2012; Lindberg and Walter, 2013). Developing and designing an exploratory design game (Brandt, 2006), the *Object Game,* contributes to the field of design games and participatory innovation (e.g., Brandt, 2006; Brandt et al., 2008; Buur and Matthews, 2008; Buur and Larsen, 2010; Vaajakallio and Mättelmaki, 2014). The *Object Game* is in itself a boundary object and is enacted into being a *sparring object* facilitating dialogue and reflection. It is an example of a management tool being functional, instrumental and prescriptive (Zeiss and Groenewegen, 2009).

Moreover, the PhD study is based on multiple case studies, which are eight collaborative innovation projects that have been part of the regional GTNV-program. These are *successful* collaborations between SMEs and Academia, and the empirical research predominantly highlights the positive aspects of collaboration innovation. There are limitations to the research study, which have been addressed in the respective chapters of the dissertation. Reflecting on the overall research process, which indeed has been a great learning process, choices by the researcher had deliberately been made throughout the PhD project. Many of the choices have been shaped by curiosity, opportunities, and timing, nonetheless.

An alternative research design, where the different actors would have been followed more closely during the collaborative projects (unlike analyzing interview data), would arguably have given 'active data' (Dubois and Gadde, 2002; 557). Active data, in contrast to 'passive data' (appears through search, e.g. interviews), is associated with discovery through observations (Dubois and Gadde, 2002). Longitudinal case studies (3-5 cases), similar to Carlile's (2002, 2004) ethnographic study on boundary objects, would have given different and more detailed data with 'rich, think descriptions' (Creswell, 2014; 2020) on other aspects of collaborative innovation projects.

Studying the eight cases in the same framework has its strengths and weaknesses. Multiple cases within the same regional *context* (GTNV-model) highlights the similarities between what all or most of the cases have experienced. In contrast, due to resource and time limitations. In-depth, longitudinal and observational studies on several cases is difficult, if not impossible, for merely one PhD researcher to conduct.

Suggestions for further research, in the process of theory building and moving from descriptive theory to normative theory (e.g., Christensen, 2006), a further investigation in new contexts is needed for a more profound understanding of the combinative use of objects needed for effective (and predictive) knowledge transfer, exchange, generation, and integration – in collaborative boundary practices. The descriptive classification of the *four S' of object-in-use (structural, spatial, sparring, situational)* needs to be developed further and tested in new contexts – in longitudinal case studies – where possible candidates of objects can be identified and assembled in a 'toolbox' for practitioners to use for effective knowledge flows in collaborative boundary practices. In addition, through observational and longitudinal studies, the *broker of human interaction* needs to be investigated further in order to attain rich descriptions of actions taken by the broker and to gain an in-depth understanding of this role in 'bridging' actors from different boundaries.

8.4. Contributions to practice and policy

The new actors – brokers facilitating interactions at *meta- and micro-level* – in the regional and national innovation system play an important role, not only in facilitating collaboration processes between SMEs and Academia, but also in supporting capability and capacity building in SMEs, which ultimately leads to improved competitiveness and the introduction of (recombinant) innovations in the national and international markets. This PhD dissertation has implications for both practitioners in boundary practices, as well as for innovation policymakers.

Time is of the essence, also in collaborative innovation projects. The time factor is potentially the greatest barrier to collaborative innovation – actors need to prioritize engaging in innovation activities. Through innovation activities, actors explore and reflect on their other (operational) activities, as well as reflect on the collaboration process, in order to learn from their actions and become aware of what can be done better or different in future collaborations and innovation activities. A tool that facilitates reflection is the *Object Game*, and other similar exploratory design games, developed for the specific purpose and context in which they are applied. The Object Game facilitates a different type of dialogue while interacting with the game pieces, creating a 'neutral boundary' for the actors to reflect on past activities.

Brokers (consultants and other 'bridge-building people') using the *Object Game* and similar exploratory design games as management tools to facilitate interaction, dialogue and reflections could help 'close the loop' of different types of collaborative projects, including *Horizon 2020* projects or other innovation projects between different actors. Developing and using a *Co-alignment game* that aligns the expectations of collaborators at the *first kick-off meeting* would add value to the process of designing collaborative processes of *whom, how, where, when,* and *why* – and potentially create better and more effective processes for collaborative innovation.

Furthermore, findings in this PhD dissertation indicates that the gap – or distance – between SMEs and Academia is not as wide as some may perceive. GTNV-program as a formalized structure that guides the different actors through the collaboration process, as well as the roles of the two types of brokers, have proven to an effective way to bridge the gap between the two worlds. Not everything can be structured for successful collaborations, but initiating demand-driven innovation policies to bridge the gap, as was done in the GTNV-program, would be a good start. To be noted, a neutral operator (knowledge broker at meta-level) coordinating and facilitating the collaboration processes is an essential ingredient to the success of the interactions between the SMEs and academic researchers in the GTNV-program.

Innovation policymakers thus need to consider demand-driven programs, such as the GTNV-program, for systematically facilitating collaborative innovation projects based on the demands of the SMEs. These programs provide access to academic knowledge and the projects facilitated by different types of brokers make combining

knowledge bases easier, and this is arguably needed in the Danish innovation system.

Innovation policies also need to consider instruments to fulfill the demand for *flexible* programs to, for instance, include the discovery phase of the innovation process with *broad exploration*,[42] where many start from *specific exploration* with knowledge search together with the external actor. SMEs also need help in finding knowledge sources (i.e., 'matchmaking') that can help identify and specify the problem to be solved. A knowledge broker could assist this phase, similar to the initial phase of the GTNV-program.

From a policy-perspective, understanding what triggers SMEs to reallocate time from operational activities and explore together with external knowledge actors is essential in designing innovation policies that make it worthwhile for SMEs to prioritize these types of collaborations and innovative activities. This dissertation contributes (partially) with drivers of collaborative innovation projects, and these need further empirical investigation in order to develop demand-driven innovation policies with the appropriate incentive structures – for SMEs and for Academia. However, understanding some of the drivers, and how collaborative innovation takes place between SMEs and Academia at micro-level through the mechanism of the (demand-driven) collaborative innovation projects, is valuable knowledge in the process of developing instruments for SMEs and Academia to combine their knowledge bases for innovative output – and ultimately economic growth.

As illustrated in the introductory part of this dissertation, merely *7.98 percent* of innovative SMEs collaborate with universities and higher educational institutions. The percentages could arguably be increased in years to come, if a greater focus (and meaning) is given to the new actors in the 'innovation game'. Neutral brokers facilitating brokerage activities for collaborative innovation and brokers of human interaction facilitating the 'right' elements of these processes could play an essential role in bridging the existing knowledge bases of SMEs and Academia and create the conditions for recombinant innovation.

[42] Please refer to *figure 2* in *chapter 4.*

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Sammendrag på dansk

Hvordan samarbejder SMV'er med Akademia? Det er omdrejningspunktet for denne ph.d.-afhandling. Virksomheder samarbejder med den akademiske verden via forskellige mekanismer, afhængig af formålet for samspillet. *Kollaborative innovationsprojekter ('collaborative innovation projects')* er mekanismen, som bliver undersøgt i denne afhandling. Vidensamarbejde faciliteres via et regionalt program og har til formål at få SMV'er til at vækste via skabelse af ny viden, strategisk forandring og innovation.

Ph.d.-afhandlingen udforsker 'brokers', 'capabilities' og 'objects' og deres roller i at få viden til at "flyde" eller "strømme" mellem henholdsvis virksomhedens og den akademiske vidensbase. Afhandlingens kerne er casestudier og et designspil – 'Videndelingsspillet' (*Object Game*). Designspillet er designet og udviklet samt anvendt i en workshop. Resultaterne fra casestudierne er integreret i designspillet, og dets formål er at undersøge objekternes rolle i kollaborative innovations-projekter. *Object Game* fungerer både som et forskningsredskab og et værktøj til at reflektere over vidensamarbejdsprocessen.

Det ultimative mål for enhver virksomhed er, at overleve eller vækste. Innovation kan føre til dette mål. Innovation er processen og udbyttet af at kombinere eksisterende idéer, som kan anvendes i en ny kontekst. Dette kan også forekomme, når en virksomhed og en forsker kombinerer deres to (forskellige) vidensbaser.

'Collaborative innovation' er således en proces, hvor to eller flere vidensbaser interagere og kombinere deres erfaringer, evner og ideer. En proces, der kan forekomme i en begrænset periode, for eksempel gennem projekter. Projekter har et start- og en sluttidspunkt – og har et formål. Et formål om at finde (gen)vejen til ny viden, vækst eller overlevelse. Kollaborative innovationsprojekter mellem SMV'er og Academia er derfor en vigtig mekanisme at undersøge, forstå og lære af.

Ph.d.-afhandlingen er opdelt i fire dele. *Del I* introducerer ph.d.-projektet og forskningstilgangen, efterfulgt af *Del II*, som er et litteraturstudie. *Del III* er den empiriske forskning (kernen i ph.d.-studiet) og *Del IV* konkluderer ved at opsummere resultaterne og diskutere bidrag til teori, praksis og innovationspolitik.

Ved at forske i kollaborative innovationsprojekter i en formaliseret struktur, et regionalt program, kan vi undersøge hvordan videnmæglere ('brokers'), kapaciteter ('capabilities') og objekter ('objects') faciliterer "vidensflowet" mellem SMV'er og Akademia. Dermed kan vi blive klogere på samarbejdsmetoder og definere (en ny) *kollaborativ praksis ved grænseflader* ('collaborative boundary practices'), der kan blive anvendt i andre kontekster, hvor aktører fra forskellige vidensbaser deler og skaber viden – som kan føre til strategiske forandringer og innovation.

APPENDICES.

- Appendix A – Firm characteristics
- Appendix B – Pilot study
- Appendix C – Interview guides: *Cases Alpha-Theta*
- Appendix D – Interview guides and questionnaire: *Case Alpha Bakery (pilot study)*
- Appendix E – Methods applied *(chapter 1)*
- Appendix F – Theme cards: Quotes
- Appendix G – Participant discussion (Theme cards)
- Appendix H – Items of the Object Game
- Appendix I – Evaluation: Object Game

Appendix A

Descriptive data on the firms in the multiple case studies

Firm characteristics	***Case Alpha Bakery***	***Case Alpha***	***Case Beta***	***Case Gamma***
Size (employees)	Approx. 130	Approx. 50	12-15	26
Established (age in year 2015)	2000 (15)	2003 (12)	2000 (15)	2009 (6)
Turnover (year)	DKK 199.5 million (2014)	DKK 19.8 million (2013)	DKK 5.3 million (2014)	DKK 14.5 million (2014)
Sector code	107110	256200	741010	265100
Location	Southern Denmark	Central Denmark	Central Denmark	Central Denmark

Firm characteristics	***Case Delta***	***Case Epsilon***	***Case Zeta***	***Case Eta***	***Case Theta***
Size	15	5	12	5	7
Established (age in 2015)	1984 (31)	2010 (5)	1976 (39)	2006 (9)	2002 (13)
Turnover (year)	DKK 5.9 million (2013)	DKK 2.9 million (2014)	DKK 16 million (2014)	DKK 3.8 million (2014)	DKK 4.2 million (2013)
Sector code	139210	620200	466900	702200	620100
Location (region)	Central Denmark	Central Denmark	Central Denmark	Central Denmark	Central Denmark

Appendix B

Pilot study

Drivers of external knowledge search and selection processes: A case study on an innovative manufacturing SME in the food industry

Diane Filip

Abstract

The case study is Danish manufacturing small and medium-sized firm (SME) in the food industry: an innovative firm in a traditional industry shaking things up and creating change. The exploratory case study is an analysis on the firm's collaborations with external actors from knowledge institutions (e.g., universities and higher educational institutions), including search activities, selection strategies, key challenges, and main drivers. Search and selection is one of the main functions of dynamic capabilities when addressing or creating change (Helfat et al., 2007); these are the microfoundations of sensing and seizing capabilities in the dynamic capabilities framework (Teece, 2007). How these processes are enacted in practice depends on the people in the firm – specifically, the behavior of the managers in the SME. This paper focuses on the external knowledge search and selection processes – and the underlying drivers. Drivers of the search and selection processes are found to be entrepreneurial spirit and curiosity of the managers in the SME. The characteristics of this type of firm include openness to collaborate, willingness to search and integrate new external knowledge, and willingness to change and adapt. The external knowledge sources are formal networks and collaborative projects. Selection processes are influenced by the external funding possibilities, primarily due to lack of resources – time, money, and people.

Keywords:
External knowledge, Capabilities, Search and select, Manufacturing SME, Drivers

1. Introduction

The objective of this pilot study is to explore an innovative manufacturing SMEs search and selection processes for external knowledge sources, what are their main drivers and key challenges, and to investigate if and how they develop and deploy dynamic capabilities by collaborating with external knowledge actors. The case study focuses on the drivers of the external knowledge search and selection strategies, including the characteristics of the firm and sources of new knowledge. A special attention is given to the firm's activities with *external knowledge actors* from knowledge institutions (e.g. universities and higher educational institutions).

This pilot study guides the empirical research conducted in the PhD study. We learn that observing dynamic capabilities and the underlying search and selection processes is difficult. However, this study does arrive at some important findings for understanding what characterizes this type of firm, what are the drivers of search and selection processes, and where does the firm source knowledge for its innovative activities.

The intent was to investigate the role of brokers in their open innovation processes. The firm has engaged with several external knowledge actors at various institutions and through different programs, and without a clear understanding of who are the 'brokers' and where are they located, it is troublesome to pinpoint their role. This is another lesson learned from the pilot study: exploring the role of brokers needs to be within a certain structure – a program – and this guided the research toward the regional program, GTNV-program, which is the central empirical lens in the PhD project.

As a pilot study, the findings highlight some of the key challenges and drivers in search and selection processes that need further investigation, including short-term collaborative projects, external funding opportunities, brokerage activities for better collaboration process, access to new knowledge, and integration of new knowledge. The GTNV-program addresses these, and therefore the GTNV-program as an empirical lens is a valuable structure to explore the different actors engaging in collaborative innovation projects where the roles of brokers, capabilities and objects are an integral part.

2. Theoretical lens

Access to external knowledge is an important driving force behind the success in innovation (Laursen and Salter, 2006). Knowledge and learning are the foundations of innovation, and the understanding thereof, is the key to progress (Lundvall, 2007). The Schumpeterian view of recombinant nature of innovation suggests a search for opportunities in distant worlds where ideas, people, and objects are combined to create something new (Hargadon, 2003, 2014). An example of a source from

recombinant innovation are collaborations between firms and knowledge institutions.

Knowledge is a crucial resource in the modern economy and learning is the most important process (Lundvall and Johnson, 1994; Lundvall, 2010), and learning is also the key process for continuous innovation (Boer, 2004). External knowledge search and selection is arguably one of the key activities for an SME, as SMEs generally have a stronger need to collaborate due to lack of internal resources (Katzy et al., 2013). Search and selection is one of the main functions of dynamic capabilities, when addressing change (Helfat et al., 2007). The search and selection processes are microfoundations of sensing and seizing capabilities (Teece, 2007).

Capabilities are the abilities to perform a set of tasks or activities, e.g. processes (Ambrosini and Bowman, 2009). It involves the integration of tangible and intangible assets, knowledge, and skills, and incorporates the knowledge of individuals and teams of how to perform given tasks (Helfat et al., 2007). Dynamic capabilities are about change (Winter, 2003) and change processes, asset selection and orchestration, and inventing and re-inventing the architecture of the firm (Helfat et al., 2007). Dynamic capabilities is the firm's capacity to purposefully create, extend, or modify its resource base (Helfat et al., 2007). This is one of many definition of dynamic capabilities, but essentially they are the abilities to address change or to create change (Teece et al., 1997); thus, change-related capabilities.

Dynamic capabilities serve two main functions when addressing change (Helfat et al., 2007). First, *search and selection,* and second, *implementation*. In other words, they include the "capacities for identifying the need or opportunity for change, formulation of a response, and implementation of a course of action" (Helfat et al., 2007; 30). The benefits from dynamic capabilities depend on the effectiveness of the underlying organizational and managerial processes that are applied (Helfat et al., 2007). Search and selection processes are microfoundations of sensing and seizing capabilities (Teece, 2007). How these processes are enacted in practice depends on the people in the firm. From a behavioral perspective, the behavior of the managers involved in various activities, such as collaborative projects to access external knowledge.

Search and selection involves decision-making and depends on the ability of managers to create, extend, or modify the resource base of the firm, e.g. dynamic *managerial* capabilities, which include asset orchestration (Helfat et al., 2007; Teece, 2007). Brokerage theories also focus on how managers recognize and recombine existing resources (Hargadon, 2014). The managers as decision makers "must collect information, analyze it, synthesize it, and act on it inside the firm" and thus must perform the search processes (Helfat et al., 2007; 26).

Relational capabilities can be perceived as a dynamic capability with the capacity to purposefully create, extend, or modify the firm's resource base *by including the resources of external partners* (Helfat et al., 2007; 66). The process of integrating

external knowledge into internal innovation is Open Innovation (Chesbrough, 2003, 2006). Essentially, open innovation and collaborating with external knowledge sources is about knowledge sharing and integrating new knowledge. The ability to exploit external knowledge is a critical component of innovative capabilities and it depends on the firm's absorptive capacity, i.e. "the ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990; 128).

Through the search and selection activities, firms accumulate know-how and thus engage in learning processes (Rothwell, 1994). Lane et al. (2006) divide the learning processes into phases of *exploration, transformation,* and *exploitation*. Activities related to exploration and exploitation are important when building knowledge (March, 1991). Effective learning is key to success and to innovative continuously (Boer and Bessant, 2004), and continuous innovation includes the core elements of continuous improvement, learning, and innovation (Boer and Gertsen, 2003).

How does a manufacturing SME in the food industry search and source external knowledge – and why? What are the drivers of the search and selection processes, and what are the sources of new knowledge? What characterizes this type of SME? These are some guiding questions in this exploratory case study research conducted in this pilot study.

3. Research methods

The case research is conducted in order to explore the specific actions taken within search and selection processes of a selected firm in the food industry, with research methods of interview techniques for data collection and triangulation of data sources for data analysis. The case study is a Danish innovative manufacturing firm in the food industry that primarily produces bakery products – with the company pseudonym, *Alpha Bakery*. The firm continuously develops concepts and products based on customer demands, and it provides a range of services along the value chain of the food industry, for bakery products and convenience foods. With less than 250 employees and a turnover less than EUR 50 million, the firm is therefore categorized as an SME, according to EU's definition[43].

Case studies address the *how* and *why* questions (Yin, 1994). The research design for the case study is an embedded single-case study (Yin, 2009). The case is an investigation of the processes where the managers' (project members) search new knowledge and select opportunities. The embedded units of analysis are the projects and activities in which the managers have engaged in. The rationale behind the selection of one case is that the manufacturing firm is a 'representative' case, where the objective is to catch the conditions of an everyday situation (Yin, 2009). The case

[43] European Commission; Europe and Industry. Accessed November 2014: http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm

example is representative of firms engaging in network activities and collaborations, however, it is 'special' for the particular industry (food industry).

Interview techniques were applied in the data collection, since qualitative research interviews attempt to understand the world from the interviewee's points of view and to uncover their lived world and the meaning of their experiences before seeking a theoretical explanation (Kvale and Brinkmann, 2009). Data collection was conducted through face-to-face semi-structured interviews with three managers: Chief Executive Officer (CEO) and co-founder, Chief Operations Officer (COO), and Innovation Manager. The managers are part of the organizational team – in fact, cross-functional team – when collaborating with external knowledge actors. The interviews were conducted in Danish at the location of the firm with duration of approximately one hour per interview. The introduction for and warm up to the interview was a short, one-page questionnaire, with the following questions that included answering options of "yes," "no," or a list of options:

- Which knowledge institutions the firm has had collaboration with?
- If they had several collaborations at once?
- If they know certain programs in the innovation policies?
- If they had applied for, or participated in, any of the programs?
- If they have a development or innovation department?
- What is their preferred length of projects with researchers?

The semi-structured interview started with a short discussion on the interviewee's answers to the questionnaire. This was a tuning-in into more factual, conceptual, and narrative questions in the interview guides. The interviews were recorded and transcribed, as well as notes were taken during the interviews. The content of the interviews was organized into main themes including collaboration, open innovation, knowledge search, and collaborative projects; thereafter, the content was written as an extended summary. Validation efforts were undertaken (Bryman, 2012), including triangulation and feedback from the interviewees for construct validity (Gibbert et al., 2008). The interviews and a follow-up extended questionnaire included topics related to the firm's external activities, search processes, motivation, challenges, and outcomes in relation to specific collaborative activities that had been mentioned in the interviews.

Triangulation across data sources was conducted on data related to the firm's projects and activities with external knowledge actors for construct validity (Gibbert et al., 2008), data quality and internal validity (Miles and Huberman, 1994). Data sources included the interviews, Annual Reports, news articles, firm's website, and websites related to the firm's external activities, e.g. websites with information on the projects and consortia of actors mentioned in the interviews.

For analytical purposes, the underlying processes of dynamic capabilities are divided into search and selection processes, as one of the two main functions of dynamic capabilities (Helfat et al., 2007). This is similar to the framework of sensing and seizing, as the main activities with organizational and managerial processes, and transforming as the implementing function (Helfat et al., 2007; Teece, 2007).

4. Case study: An innovative manufacturing SME in the food industry

Alpha Bakery is an innovative manufacturing SME in the food industry and it primarily manufactures bakery products. The firm has been in business for more than a decade and is classified as a *low-tech* manufacturing firm, according to the industry codes, i.e. NACE rev. 2. However, this does not imply the firm is not integrating high technology in its manufacturing processes.

This case illustrates the open-mindedness of a low-tech manufacturing SME and its willingness not only to collaborate with external knowledge actors but also its willingness to change and adapt to its environment (e.g. Teece et al., 1997). Alpha Bakery recognized that there were resistance in the distributions channels of the 'traditional' supply chain for bakery products, and thus realized the need to take action and adjust its strategy. The firm had to create change in the external environment in order to survive (e.g. Eisenhardt and Martin, 2000). The result of this is that Alpha Bakery has become a firm that develops and delivers concepts for its customers by providing services downstream, rather than only producing the products. During this transformational process, the firm has engaged in several projects with external knowledge actors. Although the managers did not explicitly make the direct link between the transformation and external collaborations, one should not exclude the importance and impacts of collaborative activities and external knowledge sources in this transformation.

4.1. Open Innovation and collaborative projects

Alpha Bakery is practicing Open Innovation through collaborative projects and activities to capture new knowledge from external sources (e.g. Chesbrough, 2003). New knowledge is created in the context of the firm, as critical lenses from external knowledge actors perceive the firm's processes from a different perspective than the managers, employees, or their suppliers. As the Innovation manager stated, thinking *food products* and only collaborating with actors related to the food industry is not enough. By being open-minded and perceiving how things are done in new ways, the firm is learning by thinking differently and openly in collaboration with knowledge actors.

The COO's perspective on Open Innovation is that limited raw materials and resources create real innovation; it is about being innovative in the ways of thinking, in order to create new products from the limitations. This is where the challenge

with innovation lies, according to the COO. The CEO has a more systemic view on Open Innovation: it is about having different partners in the whole value chain. In regards to the process, it is about having partners in the development of products, processes, and technical capabilities in manufacturing and towards the customer.

The perception of collaboration, in general, is *"one plus one equals three."* There are synergistic effects when products, processes, and ways of doing things are assessed from various points of views – from the different actors involved. Through an open dialogue, two or more actors can jointly *turn* the problem. Thus, a holistic assessment is obtained through the collaboration. Transforming knowledge from each actor's "thought worlds" (Dougherty, 1992) into new knowledge is a pragmatic approach where "boundary objects" (Carlile, 2002) are the *processes* in the firm under scrutiny. However, too many actors involved can impede the collaboration process. The COO explains the meaning of collaboration:

> "Collaboration does not mean that people sit down at a table, drink coffee or tea, and say 'now we have to agree on…' Collaboration means that people share their different perspectives. There is one leader, who makes the final decision. This decision is based on input from everyone; it is not based on same input from all. Collaboration is not so much *consensus-based* as it is *commitment-based*."

4.2. Search and select external knowledge sources

The search processes of the firm for knowledge outside is effectuated with a purpose. As the CEO states, "The search activities are more targeted and goal-oriented than one might think." Alpha Bakery engages in external activities through network participation that are untraditional for a manufacturing firm in the food industry. The firm partakes in network activities with unrelated or peripheral actors to bakery products in order to develop relationships with actors that are very diverse to the firm – for instance, where *bakery meets design*. Engaging in multi-party networks (Garud et al., 2013) with a variety of actors, is an example of a firm connecting "distant worlds" (Hargadon, 2003, 2014) and "thought worlds" (Dougherty, 1992) by identifying and seizing "the strength of weak ties" (Granovetter, 1973). By communicating its visions and values, the firm has become an interesting collaboration partner to other external organizations and knowledge institutions. Building relationships through network activities and becoming visible to others, Alpha Bakery as the untraditional food-manufacturing firm it is, started to be invited into collaborative projects with external actors. Thus, network activities are part of the firm's search processes for new knowledge and selection of opportunities. The external knowledge search and sourcing is based on the managers' ability to search and identify new opportunities (Helfat et al., 2007; Teece, 2007; Zahra et al., 2006; Winter, 2003).

At the time of the interviews, Alpha Bakery had four projects with external knowledge actors, and had recently completed three similar projects. The majority

of the projects were on process improvements, e.g. *hard processes*, such as manufacturing and new product development processes, rather than *soft processes* (i.e., communication and organizational culture). The routines of collaborative projects are relatively stable and learned patterns of collective activity (e.g., Zollo and Winter, 2002). These projects are bilateral or multilateral with the external parties as the lead on majority of the collaborative project; the external actors have the role of project managers. Project durations range from less than half a year to three years, and routines include frequent face-to-face meetings (weekly, bimonthly, or as needed). Manufacturing (and Supply Chain) and New Product Development are primarily involved in those projects – cross-functional team include managers from these areas. Managers from Sales and Finance have also participated in external projects, either individually or in a cross-functional team. Nonetheless, Alpha Bakery's core cross-functional team consists of the COO and Innovation Manager; both have routines to perform and to coordinate individual tasks (e.g., Helfat and Peteraf, 2003) within the firm and across various collaborative projects with external actors.

4.3. Key challenges

The greatest challenges identified in the case study are related to long-term projects that last between two and three years. The Alpha Bakery's collaborative projects with knowledge institutions are formally between a firm and an institution; however, projects are between people, and when organizational changes occur at either side of the collaboration, then new people enter the project. As perceived by Alpha Bakery, this is an issue, since they have the feeling of starting over again, as a new external person is sitting at the other side of the table. Project participants had felt frustrated when being faced with this type of external challenge. To overcome this (potential) challenge, Alpha Bakery prefers shorter project that lasts 6 months to one year. The firm wants to get and see results in the short run rather to invest in long-term projects. As the COO explained, projects on extended duration tend to shift direction as the projects progress, and one might forget where and why the project was started in the first place.

Other challenges that the firm is facing are internal challenges. Alpha Bakery is participating in many activities and involved in several projects with external actors. The firm is potentially involved in *too many* projects and activities as it is accepting many of the invitations from external sources. When does being open become too open? Some of the concerns of the managers is that they, as a firm, are sharing a lot of information and data with external knowledge sources. Resources allocated to collaborative projects could have been deployed in operational activities; resources, including people, time, financial, are limited. The managers are starting to prioritize what is relevant and important, compared to what is interesting but not vital for the firm. This indicates that Alpha Bakery has acknowledged that being too open will distract them from their core activities.

Finally, the need for financial support is also apparent. In general, SMEs lack human and financial resources to devote to innovative efforts and practices (Parrilli et al., 2010). Alpha Bakery has preferences towards publicly funded collaborative projects, and external knowledge actors should lead those. External funding is available to firms and knowledge actors for engaging in collaborative projects. This availability and access to external funding influences the firm's selection processes. Their knowledge sourcing strategy – and selection of external knowledge through projects – is influenced by the availability external financial support.

4.4. Main drivers

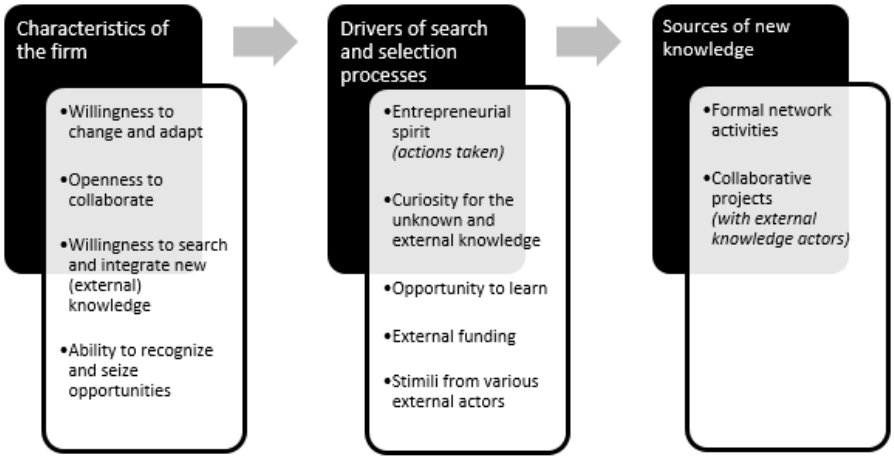
The main drivers of Alpha Bakery are curiosity and entrepreneurial actions of the managers, including recognizing opportunities to collaborate with external actors in relatively distant worlds. The access to, and possibility of gaining, the newest knowledge from external sources is identified as the greatest motivational factor. Pursuing *one time opportunities* for knowledge brokering from distant worlds (Hargadon, 2003) is a strategy to acquire knowledge, and to transform it to new knowledge, in order to implement new ways of doing things, e.g. processes. New knowledge to solve various issues – through the eyes and lenses of external actors – is at the heart of the firm's engagement in external activities. Openness and willingness to collaborate – and to change – are essential traits of this manufacturing firm. Especially the managers are willing to invest resources (time) in collaborative projects, and they are willing to change based on the outcome of these projects to ensure impact.

The firm engages in learning processes when collaborating with external knowledge actors. The innovation process can be divided into invention, development and implementation of ideas across multi-party networks (Garud et al., 2003). The focus of the collaborative projects, mentioned by Alpha Bakery, is on invention and development, whereas the implementation is up to the firm (or firms if more are involved) to ensure either after the completion of the projects – or as a parallel integration into the firm operational capabilities. The boundary objects (Carlile, 2002) in most of the firm's collaborative projects are *hard processes* (e.g., process innovation); this means that the firm develops its processes, including manufacturing processes, with external actors. Nonetheless, the CEO is touching on the importance of the softer side of collaborative projects, as he underscores that learning is the most important outcome of projects: "The most important learning is in the process – more than in the output itself." This learning process has arguably had an impact on the transformation of the firm (e.g., Teece, 2007). Actively engaging in projects with external partners is a source of organizational learning, and in turn, a mechanism for developing and deploying dynamic capabilities (Zollo and Winter, 2002; Helfat et al., 2007).

Figure 1 summarizes the *characteristics of this firm*, the *drivers for search and selection processes*, and the *sources of new knowledge*. It may be argued that the characteristics of the firm enable the drivers; these are preconditions or the foundation that fuel the identified drivers. The characteristics of the firm, which are to a great extent shaped by the existing organizational culture (values and norms), include willingness to change and adapt, openness to collaborate, as well as willingness to search and integrate new external knowledge. The manager's ability to recognize and seize opportunities is arguably a precondition for selecting and benefitting from external knowledge sourcing.

The *internal* drivers are curiosity and entrepreneurial spirit. The latter is the actions taken by the managers. The *external* drivers are opportunities to learn, external funding, and stimuli from various external actors who invite the firm into projects and other collaborative activities. The sources of new (external) knowledge identified at Alpha Bakery are formal *networks* that are different from the food industry actors, and *collaborative projects,* which are formal channels for knowledge sharing and knowledge integration (e.g., Bengtsson et al., 2015).

Figure 1. Characteristics, drivers of search and selection processes, and sources of new knowledge.



5. Discussions

This exploratory case study is a micro-level view on the firm's search activities, selection processes, and external knowledge practices. The manufacturing SME, Alpha Bakery, creates change through an active search and selection process driven by actions taken by the managers. The managers' entrepreneurial behaviors and curiosity are drivers in the search for external knowledge. The firm engages in Open Innovation practices by incorporating resources, including intangible assets such as knowledge from external knowledge sources through collaborative projects (Chesbrough, 2003). Another source of external knowledge is through active participation in formal network activities.

The search for new knowledge is a targeted and goal-oriented search for external knowledge. As *figure 1* illustrates, external activities and projects with external actors are sources of new knowledge. In turn, new knowledge is a source of innovation, as the firm practices a conscious and purposeful search for innovation opportunities (e.g., Drucker, 1985). In the case of the manufacturing SME, the critical lenses of external knowledge actors is also a potential source of innovation, as the firm may change perception on for instance a given object. As Drucker (1985) states, "A change in perception does not alter facts. It changes their meaning, though – and quickly" (p.6). Collaborative projects could, in turn, be sources of change and continuous innovation, e.g. doing something differently or doing something better (Boer and Bessant, 2004).

In the dynamic capabilities view, the search activities are microfoundations for sensing capabilities, in the triad of sensing, seizing and transforming underpinning dynamic capabilities (Teece, 2007). As previously stated, the firm's search processes include network activities and collaborative projects, in and with distant worlds (Hargadon, 2003). It seizes the given opportunities by brokering knowledge for *one time opportunities*, such as moving or incorporating ideas, people, and artefacts from other distant worlds by having project members or activity members act as knowledge brokers (Hargadon, 2003). The firm searches and selects opportunities across multi-party networks (e.g., Garud et al, 2013) and with specific knowledge actors, in order to utilize the strength of weak ties and to build strong ties for better knowledge transformation (e.g., Granovetter, 1973; Carlile, 2002). Search activities include network activities, where the search for opportunities in distant networks is a strategy of brokerage (Hargadon, 2014). The firm builds *relational* capabilities by engaging in collaborative projects with external actors from other networks or thought worlds (e.g., Dougherty, 1992). The managers, who are actively involved in the project teams, build these capabilities, and thereby the firm purposefully creates, extends, or modifies its resource base by including external resources (e.g., Helfat et al., 2007).

Investment strategies are guided by the available external funding possibilities. The firm is pursuing collaborative projects where the investment level by the firm is relatively limited to the resources of time and people. Therefore, funding

opportunities in the external environment influences the strategies of Alpha Bakery for gaining new knowledge from external sources. Thus, the managers' abilities to create, extend, or modify the resource base, combined with the available external funding, shape the firm's selection processes. Continuously practicing Open Innovation through collaborative projects harnesses these capabilities of including external resources into the firm's resource base. Over time, the managers are building and implementing dynamic *managerial* capabilities to address change or to create change.

This case study underscores that the managerial behavior, the actions taken by the managers, is seeking knowledge in distant worlds (e.g., Hargadon, 2003) to be inspired to do something differently or better. This has implications for continuous improvement, learning, and ultimately continuous innovation in the firm (e.g., Boer and Gertsen, 2003; Boer and Bessant, 2004). There are plenty of sources for new knowledge to the firm. In the case study, those are formal networks and collaborative projects with several external knowledge actors (from universities and higher educational institutions). The availability of external funding influences the choices of the managers, as well as how many of their own resources – time, people, money – they need to reallocate for the collaborative projects. The lack of internal resources is a limitation to the firm, and the managerial behavior is guided by these constraints.

Nonetheless, the choices of engaging in formal network activities and collaborative projects has implications for the firm's knowledge sharing practices with external (knowledge) actors. The managers interact with external sources to share knowledge – both outbound and inbound – to learn and to be inspired to make changes that could result in, for instance, organizational or process innovation. The learning from the collaborations process is perhaps more important than the outcome of a given collaborative project.

Moreover, the findings from this study has also implications for policy. The external funding availability influences how the SME selects collaborative projects; therefore, if policy makers aim to create policies that facilitate innovation and growth in SMEs, then gaining an understanding of the choices made by SMEs like Alpha Bakery, is vital for the future of SMEs. Financial incentives is one parameter, however the length, size and flexibility of the collaborative (innovation) projects also affect the behaviors. Stimuli from external sources, including knowledge institutions, and the external actors' available resources (people and time) influences the decision-making process of the managers. It comes down to balancing between reallocation of internal resources from operations and day-to-day survival activities, to projects that promise improvements, change, and survival in the long-term.

Furthermore, the *technical fitness* of capabilities tells us how effective the capabilities are (Helfat et al., 2007). In theory, the more the firm collaborates with external knowledge actors on collaborative projects to change or adjust the resource base of the firm, the more *technical fit* the capability will become over time. This increases the possibility of enhancing the *evolutionary fitness* of the firm in the long run, which is the survival, growth, and value creation of the firm (Helfat et al., 2007). The underlying assumption is that the firm is accumulating know-how; it is a learning process (Rothwell, 1994) on both content (the *what*) and about the collaboration process (the *how*). This strengthens the *technical fitness* of its *relational, dynamic* capabilities, which are essential to the long-term fitness of firms.

There are limitations to this study, as the findings from the case study are not generalizable to *all* innovative manufacturing SMEs. This descriptive case pinpoints how one particular (and successful) firm applies its dynamic and relational capabilities. This study only scratches the surface of external knowledge search and sourcing. However, as a pilot study, it highlights some of the key challenges and drivers in search and selection processes that need further investigation: short-term collaborative projects, external funding opportunities, brokerage activities for better collaboration process, access to new knowledge, and integration of new knowledge.

Appendix C

This appendix includes the interview guides for the cases Alpha-Theta (in Danish). The interviews in cases Delta-Theta were carried out by co-authors and research colleagues at Centre for Entrepreneurship and Innovation, Aarhus University.

Interviewguide: Alpha, Beta, Gamma (virksomhed)

Introduktion

- Lidt om mig og PhD'en
- Formål med vores møde i dag (effektive/ineffektive objekter) og kort intro til 'outline'
    - Opvarmning, hvem-hvad-hvor, motivation, forløbet, objekter/værktøjer, udbytte, begreber, næste skridt

"Opvarmning"

- Hvad er jeres primære produkt?
- Hvor meget eksport har I?
- Hvad er jeres vigtigste marked? Og kunde?
- Hvor mange er I p.t. i *XX*?

1. Hvem – hvad – og hvor?

- Hvornår startede I og hvornår afsluttede I jeres Genvej til Ny Viden-projektet?
- Hvem deltog i projektet? (fra *XX*)
- Hvem samarbejdede I med?
    - Hvor mange forskere? Hvorfra?
    - Hvorfor disse forskere?
- Har I deltaget i andre projekter samtidigt med Genvej? (med forskere?)
- Deltager I i andre projekter? (med forskere?)
- Hvad var formålet med jeres Genvej-projekt?
    - Nyt produkt?
    - Nye processer?
    - Ny indsigt/viden/kompetencer?
- Hvad var jeres behov?
- Har projektet været tæt koblet til virksomhedens strategisk mål?
- Hvem havde I som facilitator? (navn og institution)
    - Hvilken rolle spillede facilitatoren i jeres forløb?
- Hvad har været jeres rolle i samarbejdet?

2. Motivation [hvorfor]

- Hvorfor valgte I at deltage i Genvej til Ny Viden?
    - En motiverende projektramme?
    - Interessant koncept?
    - Pga. facilitering?
    - Funding/penge?
- Ville I have samarbejdet med de samme forskere – eller have haft et lignende projekt, hvis I ikke havde kendskab til GTNV?
- Giver jeres deltagelse i projektet – og jeres samarbejde med forskeren/forskerne – anledning til lignende projekter?
- Hvad var jeres succeskriterier for samarbejdet/projektet?

3. Samarbejde/forløb [hvordan]

- Hvordan forløb jeres projekt/samarbejde?
- Hvad har været afgørende for jeres samarbejde? Beskriv gerne en konkret situation.
- Har der været udfordringer med samarbejdet?
    - Hvordan fik I løst udfordringen/udfordringerne?
- Hvordan samarbejdede I? Giv nogle eksempler.
    - Mødtes I "face-to-face"?
    - Workshops? Møder?
    - Hvor ofte mødtes I?

4. Objekter [værktøjer/hvordan]

- Hvilke objekter – dvs. værktøjer – brugte i undervejs i jeres forløb?
    - Præsentationer (PowerPoints)
    - Tegninger / blueprints
    - Gantt skema eller lignende projektledelsesværktøjer
    - LEGO
    - Ansøgning (og andet)
- Hvilke af disse objekter har været *effektive* i jeres samarbejde?
- Hvilke af disse objekter har været *ineffektive* i jeres samarbejde?

5. Virksomhedens udbytte

- Har I opnået det ønskede med projektet?
- Er der skabt ny viden i samarbejdet?
    - Ny viden har ført til…
        - Nyt produkt
        - Nyt kundegrundlag
        - Nyt forretningsområde og/eller forretningsplan
        - Styrket selvindsigt og dermed til ændrede strategier
        - Nye handlemåder
        - Nye kompetencer til virksomheden
        - Nye måder at videndele på (internt i virksomheden)
        - Nye konkurrencemuligheder
- Hvordan bliver den nye viden forankret internt? Hos medarbejderne/ledelsen?
- Hvilke forandringer har samarbejdet/projektet før til internt? Og eksternt?
- Hvorledes har projektet (og udviklingen af produktet) betydning for virksomhedens strategi?
- Hvilken betydning har samarbejdet nu og fremadrettet? (1-2 år)
    - Vækst?
    - Mersalg?
    - Nye kunder?
    - Andre afledte effekter?

6. Forståelse/fortolkning af begreber

- Hvad forstår du ved innovation? Eller, hvordan fortolker du Innovation?
    - Har denne forståelse ændret sig i løbet af projektet?
- Hvad forstår du ved vidensamarbejde? Eller hvordan fortolker du Vidensamarbejde?
    - Har denne forståelse ændret sig i løbet af projektet?

7. Næste skridt

- Hvad er næste skridt for jer (virksomheden)?
- Har I planer om at samarbejde med forskere igen?
    - I hvilken form? Projekter?
    - Med fokus på…?

Interviewguide: Alpha (facilitator)

Introduktion

- Lidt om mig og PhD'en
- Formål med vores møde i dag
    - Høre om din rolle i Genvej-projektet
- Outline:
    - Din baggrund
    - Din rolle i samarbejdet
    - Samarbejdsforløbet
    - Udbytte
    - Begreber
    - Næste skridt

1. Din baggrund

- Hvad er din baggrund?
- Fortæl lidt om *XX*
    - Hvad I laver?
    - Hvad er din rolle/funktion ved *XX*?
- Havde du erfaring med at facilitere (være projektleder) på eksterne projekter, som Genvejs-projektet, eller var det nyt for dig?

2. Din rolle i samarbejdet

- Hvordan kom du med i Genvejs-projektet? Og hvornår i forløbet? (fase 1 eller fase 2)
- Hvorfor valgte du at være facilitator for denne type samarbejde?
    - Hvad var motivationsfaktoren?
- Har du haft andre Genvejs-projekter ud over *case Alpha*?
- Hvad var din rolle i *Alphas* projekt? Giv nogle konkrete eksempler på opgaver.

3. Samarbejdsforløbet

- Hvordan samarbejdede I?
    - Mødtes I face-to-face?
    - Workshops?
    - Hvor ofte mødtes I? Og hvor?
    - Hvordan delte I viden?
        - Mails, face-to-face, telefon, Skype?
        - Præsentationer?
        - Tegninger?
        - Andet?
- Hvad var ansøgningens rolle i jeres samarbejde?
    - Hvem skrev ansøgningen?
    - Var du med udarbejdelse af indhold til ansøgning?
- Har der været udfordringer med samarbejdet?
    - Hvis ja, hvordan fik I det løst?
- Hvad har været det mest afgørende for samarbejdet? (Beskriv gerne en konkret situation)

4. Udbytte

- Hvad fik du ud af at være facilitator?
- Efter din mening, hvad er det mest betydelige *Alpha* har fået ud af samarbejdet?
    - Fik de deres behov opfyldt?
- Hvilken betydning har gennemførelsen af projektet med en forsker for *Alpha*?
    - (Efter din mening)
- Kan du nævne nogle afledte effekter?
    - For dig?

- For virksomheden?
- For forskerne?

5. Begreber:

- Hvad forstår du ved innovation?
- Hvad forstår du ved vidensamarbejde?

6. Næste skridt?

- Hvad er din relation til *Alpha* (*direktør*) efter samarbejdet?
- Hvor realistisk er det at *Alpha* kommer til at samarbejde med forskere i fremtiden?
- Hvordan ser du din rolle i et fremtidigt vidensamarbejde? Er der noget du ville gøre anderledes næste gang?

Interviewguide: Delta-Theta (virksomhed)

1. Motivation for at indgå i GTNV

Hvad var Jeres motivation for at indgå i GTNV fx:

- Eks. brændende platform, et "åbent vindue"
- vækstmulighed i form af:
  - nyt produkt (som adgang til vækst)
  - ny indsigt/viden/handlekraft/processer (som adgang til vækst)
- Udvikling på længere sigt – kompetenceudvikling gennem samarbejde
- Konkurrenceforhold og analyse af muligheder samt strategisk
- En god og motiverende projektramme, som passer godt til os
- Andet?

2. Forestillinger og forventninger

- Hvad var dine/Jeres forhåndsforventninger til samarbejdet?
- Hvordan vil du/I beskrive dine/jeres succeskriterier til samarbejdet?
- Har du oplevet, at forskerne havde nogle forhåndsforventninger til jer?
- Er der noget, der har overrasket dig/jer – positivt, negativt?

3. Samarbejde, kommunikation og relation med forskerne – som det kom til at forløbe

- Hvordan har du/I oplevet samarbejdet og kommunikationen med forskerne?
  - Har i talt samme sprog fra starten?
  - Så I ens på behov?
- Hvad ser du/I har været afgørende for jeres videnssamarbejde – beskriv gerne en konkret situation
- Beskriv det første møde med forskerne og det sidste møde - og hvad skete der imellem?
- Hvordan har i samarbejdet?
  - Fx workshop, møder, sidemandsoplæring
- Hvad har været jeres rolle i samarbejdet?
- Hvad har været jeres største bidrag? Hvem har været involveret? Og hvordan?
  - Og forskernes største bidrag?
- Hvordan tror du forskerne vil beskrive samarbejdet?
- Hvad har været det mest positive ved samarbejdet?
- Har der været udfordringer med samarbejdet?
  - Hvad løste op for udfordringer?

4. Facilitatorrolle

- Hvornår kom facilitator ind i jeres GTNV-faseforløb?
- Hvordan har facilitator faciliteret? Er der fx afholdt workshops? Løbende kontakt/sparring?
- Hvordan har facilitator helt konkret påvirket jeres samarbejde med forskerne?
- Har du/I haft medbestemmelse i forhold til, hvordan faciliteringsopgaven skulle gribes an under jeres videnssamarbejde? (Løbende justeringer/forventningsafstemning med facilitator)
- I hvilke situationer har der været mest brug for facilitator?
- Hvad har facilitator bidraget med i processen?
    - Kan du/I beskrive en helt konkret situation, hvor du/I har oplevet, at videnssamarbejdet er blevet direkte styrket af facilitator?
- Har du/I oplevet, at facilitator på noget tidspunkt er overflødig? Hvornår/hvordan?
- Hvordan ville jeres videnssamarbejde være forløbet, hvis der ikke havde været en facilitator?
- Har du/I forslag til forbedringer i forhold til facilitatorrollen i GTNV?

5. Virksomhedens udbytte – forankring og videreførelse

- Har I opnået det I ønskede med projektet?
    - (Koblet til formålet i ansøgningen)
- Har projektet været tæt koblet til virksomhedens strategiske mål?
- Er der skabt ny viden i samarbejdet/projektet? Hvilken karakter har den ny viden:
    - Ny viden har ført til nyt produkt (kundegrundlag, forretningsområde og forretningsplan)
    - Ny viden har ført til styrket selvindsigt og dermed til ændrede strategier
    - Ny viden har ført til nye handlemåder
    - Ny viden har tilført nye kompetencer til virksomheden
    - Nye måder at videndele på internt i virksomheden?
    - Ny viden har ført til nye konkurrencemuligheder

- Hvordan bliver den nye viden blevet forankret hos medarbejdere/ledelse /i virksomheden/ i produktet?

- Hvilke forandringer har samarbejdet ført til internt? Og eksternt?
    - Hvorledes har projektet og udviklingen af (produktet) betydning for virksomhedens strategi?
- Hvilken betydning har samarbejdet nu og fremadrettet (1-2) år (Eks. mersalg, nye kunder eller andre afledte effekter)
- Hvordan vurderer du/I muligheder for, at samarbejdet kan føre til vækst/har ført til vækst?
    - Hvilke betingelser skal være til stede/har været til stede?
- Hvordan ser du/I på virksomheden mulighed for vækst på langt sigt?
- Har I arbejdet med en forretningsplan for kommercialisering af produktet?
    - Hvis ja, hvordan og hvilke faktorer er af betydning for dette arbejde?
    - Hvis nej, har i planer om at påbegynde dette arbejde?/ Har i brug for hjælp til dette?
- Ser du nogen afledte effekter af samarbejdet/projektet? Fx: det at arbejde i projektstruktur, markedsføring af samarbejde med AU/forsker? Andet?
- Ville I gøre det igen?

6. Projektets rammer, organisering og relation til CEI/GTNV

- Hvordan har du/I oplevet, at projektets tilrettelæggelse og faser (Fase 1 og 2?) har fungeret for dig/Jer?
- Ville i have påbegyndt et samarbejde med forskere, hvis der ikke havde været tilskud fra GTNV?
    - Hvordan har du/I oplevet kommunikation, sparring, m.m. om GTNV fra CEI?
    - Har du/I forslag til forbedringer?

7. **Forståelse af begreber: innovation**
   - Hvad forstår du/I ved innovation? – og har den forståelse ændret sig i løbet af projektet?
   - I hvor høj grad ser du/I innovation som:
     - Produktudvikling? (*something to live from)*
     - Udvikling af produktions- og samarbejdsprocesser?
     - Udvikling af indsigt, værdier, selvforståelse, handlemuligheder, adfærd og samarbejdsrelationer? (*something to live for)*
   - Har din/jeres forståelse af innovation betydning for fremtidige strategier/organiseringer i din virksomhed?

8. **Forståelse af begreber: vidensamarbejde**
   - Hvad forstår du/I ved vidensamarbejde? – har den forståelse ændret sig undervejs?
   - Hvis der er fremkommet en ny viden, hvordan er den nye viden fremkommet:
     - Gennem en proces styret af fastlagte mål for innovationen?
     - Gennem samarbejdets faciliterede møder, workshops, undersøgelser (andet?)
   - Beskriv kort hvordan du oplevede midtvejsworkshoppen, og hvad den satte i gang?
     - Hvilket vidensbegreb arbejdede I med på workshoppen?
   - Er den nye viden et mål du/I havde formuleret på forhånd eller i højere grad et udbytte, som er fremkommet gennem samarbejdet?
   - Hvad mener du/I har afgørende betydning i et vidensamarbejde for en SMV?

9. **Fremadrettet interesse i at samarbejde med forskere**
   - Kunne du/I have interesseret i at samarbejde med forskere igen?
     - Begrund: Hvorfor/hvorfor ikke?

10. **Hvad er næste skridt nu for dig/Jer?**
    - Herunder er der noget CEI kan være behjælpelig med?

Interviewguide: Delta-Theta (forsker)

1. **Motivation for at deltage**
   - Hvad fik dig til at gå ind i projektet– hvad var din stærkeste motivation - og hvordan har du begrundet din deltagelse overfor kolleger? Og familie/venner?
     Fx forskningsrelaterede:
     - Afprøvning af forskningsresultater i praksis (samt evidens indsamling)
     - Indsamling af case-materiale til undervisning (teori/praksis)
     - Dokumentation af eksterne partnerskaber mhp ansøgninger

     Fx mere fagligt relaterede (Bruge andre sider af sig selv som forsker og andre dimensioner af forskning/viden):
     - Bidrage i et bredere og mere anvendelsesorienteret vidensamarbejde
     - Din vision for faget, forskningsresultatet, for læring/uddannelse
     - Nyt fagfællesskab med SMV fx socialt, samfundsorienteret accept og legitimitet (*scientific social responsibility*)
     - Merit og former for merit/anerkendelse, incitament formelt og uformelt
     - Kompetenceudvikling gennem samarbejde

     Fx personligt relateret:
     - Nysgerrighed, åben tænkning (kreativitet)
     - Ønske om luftforandring (personlig indstilling))
     - Se sig selv agere i andre sammenhænge (personlig indstilling)
     - Gøre forskel for andre/skabe værdi (omverdensorientering)

2. **Konkrete erfaringer (tidligere)**
   - Hvilke erfaringer har du fra tidligere med at arbejde med virksomheder (SMV, store virksomheder, rekvireret viden)?
   - Hvilke aktiviteter har du deltaget i?
   - Beskriv dine konkrete bidrag? (organisering, formidling, tests/forsøg, metodisk støtte, sparring, viden i anvendelse - andet?)

3. **Forestillinger og forventninger**
   - Beskriv dine forestillinger om/forventninger til samarbejdet
   - Har du oplevet, at din SMV havde særlige forventninger til dig på forhånd?
   - Hvordan vil du beskrive dine succeskriterier for et vidensamarbejde?
   - Hvilken rolle tænker du for dig selv heri?
   - Hvad har overrasket dig: Positivt? Negativt?

4. **Samarbejde, kommunikation og relation**
   - Hvordan har du oplevet samarbejdet og kommunikationen med din SMV i centrale faser i samarbejdet?
   - Hvad ser du har været afgørende for jeres samarbejde – beskriv gerne en konkret situation
   - Karakteriser det første møde – og det sidste? Og hvad skete der imellem? For dig/SMV
   - Har der været faser i samarbejdet, som du så var vanskelige – hvorfor, hvad løste dem?
   - For langt de fleste projekters vedkommende har behovet for innovation/viden været meget tæt knyttet til virksomhedens strategi (bl.a. gennem ledelse) – hvordan har du oplevet det?
   - Hvilke tegn ser du på, at din SMV's innovation og vækstmulighed er lykkes/mislykkes?

5. **Projektets rammer, organisering og relation til CEI**
   - Hvordan har du oplevet, at projektets tilrettelæggelse og faser (fase 1 og 2) har fungeret for SMV? Og jeres samarbejde?
   - Hvordan har du oplevet kommunikation, sparring, tidsforbrug, andet?

- Er der ting, du vil anbefale, bliver taget hånd om i en anden projektrunde (fx sparring til forsker, facilitering af møde, deltagelse i midtvejsmøde andet?)
- Har du forslag/anbefalinger til metode- og eller proces-udvikling?

6. Facilitators rolle

- Hvilken rolle har facilitator haft i projektet?
- Hvad har facilitator bidraget med i processen?
- Hvad ser du er den væsentligste opgave for facilitator?
- Hvad er efter din vurdering de mest stimulerende rammer for et vidensamarbejde?

7. Udbytte af vidensamarbejdet (proces og produkt)

- Hvordan har du oplevet, at du som forsker bedst kunne bidrag til din SMV's vækst og videreudvikling?
- Oplever du, det har været din indsats værd? Begrund hvorfor, hvad var afgørende?
- Er du motiveret for at indgå i et lignende samarbejde igen?
- Kan du bruge denne erfaring i dit fagfællesskab – og har du fortalt om det?
    - (formidling af forskningsresultater, anvendelsesorientering, læring i samarbejde om virkelige problemstillinger)
    - Netværk og inspiration til ny forskning?
- Hvad ser du, som din SMV's største indsats?
- Hvad tror du, SMV ser som din største indsats?

8. Forståelser af vækst

- Din forståelse af "vækst" før og nu: Hvordan vil du definere vækst før og nu?
- Hvad er mest afgørende for, at der sker "vækst"?

9. Forståelse af innovation

- Hvad forstår du/I ved innovation? – og har den forståelse ændret sig i løbet af projektet?
- I hvor høj grad ser du innovation som:
    - Produktudvikling? (*something to live from)*
    - Udvikling af produktions- og samarbejdsprocesser?
    - Udvikling af indsigt, værdier, selvforståelse, handlemuligheder, adfærd og arbejdsrelationer? (*something to live for)*

10. Forståelse af Vidensamarbejde

- Hvad forstår du ved vidensamarbejde? – har den forståelse ændret sig undervejs?
- Hvis der er fremkommet en ny viden, hvordan er den nye viden fremkommet:
    - Gennem en proces styret af fastlagte mål for innovationen?
    - Gennem samarbejdets faciliterede møder, workshops, undersøgelser (andet?)
- Beskriv kort hvordan du oplevede midtvejsworkshoppen, og hvad den satte i gang?
    - Hvilket vidensbegreb arbejdede I med på workshoppen?
- Er den nye viden et mål du/I havde formuleret på forhånd eller i højere grad et udbytte, som er fremkommet gennem samarbejdet?
- Hvad mener du har afgørende betydning i et vidensamarbejde for en SMV?
- Forståelse af "innovation" før og nu: Hvordan vil du karakterisere den type innovationsproces, du har bidraget til?
- Forståelse af "viden" (og videnbaseret samarbejde) før og nu? Hvem har viden? Hvordan udveksles den? Hvad støtter videnudveksling?

11. Kunne du tænke dig at indgå et lignende samarbejde igen?

12. Andre ting, du ønsker at fremhæve?

Interviewguide: Delta-Theta (facilitator)

1. **Konkrete erfaringer (tidligere)**
   - Hvilke erfaringer har du fra tidligere med at facilitere projekter mellem virksomhed og vidensinstitutioner (rekvireret viden)?
   - Hvilken type organisation er det foregået i (erhvervsråd, region, andet?)
   - Beskriv dine konkrete opgaveerfaringer: hvad har du bidraget med? (organisering, match-making, mødeledelse, procesfacilitering, workshopleder)

2. **Motivation for at deltage**
   - Hvad fik dig til at gå ind i projektet:
     - Det var en ny måde at skabe vidensamarbejde på som særligt…
     - Det var en udfordring, som jeg gerne ville tage, fordi...?
     - Det var en stimulerende opgave, og jeg havde nogle gode bud på…
     - Det var en opgave som min organisation ønsker at tage mhp…
   - Hvad så du som projektets (GTVN) stærkeste led? Og det svageste led?
   - Vidste du på forhånd, hvordan din funktion ville blive?

3. **Hvilke forventninger havde du på forhånd til projekt GTNV?**
   - Beskriv dine forventninger til projektet
   - Har du oplevet, at SMVer, GTNV eller forsker havde særlige forventninger til dig på forhånd?
     - Hvordan har du håndteret det?
   - Hvordan vil du beskrive din faglige tilgang til facilitering og dine succeskriterier?
     - Beskriv dine funktioner og opgaver heri?

4. **Din rolle som facilitator**
   - Hvilke opgaver har ligget i din rolle som facilitator?
   - Hvordan har du læst din position som facilitator?
   - Har du skiftet position undervejs – hvorfor?
   - Hvilke metoder har du anvendt?
   - Hvordan vurderer du at din metode har fungeret?

5. **Samarbejde, kommunikation og relation**
   - **GTNV ser facilitatorrollen som projektets stærke og karakteriserende led – er du enig heri?**
   - Hvordan har du oplevet samarbejdet og kommunikationen mellem SMV, forsker og dig i centrale faser i samarbejdet?
   - Hvad ser du har været afgørende for jeres samarbejde – beskriv gerne en konkret situation!
   - Har der været faser i samarbejdet, som du så var vanskelige – hvorfor, hvad løste dem?
   - Blev dine funktioner og opgaver i projektet, som du havde forestillet dig? Uddyb!
   - For langt de fleste projekters vedkommende har behovet for innovation/viden været meget tæt knyttet til virksomhedens strategi (bl.a. gennem ledelse) – hvordan har du oplevet det?

6. **Projektets rammer og organisering**
   - Hvordan har du oplevet, at projektets tilrettelæggelse og faser har fungeret for SMV og forsker? Og jeres samarbejde?
   - Hvordan har du oplevet kommunikation, sparring, tidsforbrug, andet i forhold til GTNV/CEI?
   - Er der ting, du vil anbefale, bliver taget hånd om i en anden projektrunde (fx sparring til facilitering, møde mellem facilitatorer, møder mellem SMV og flere facilitatorer)
   - Har du forslag/anbefalinger til metode- og eller proces-udvikling?

7. **Din vurdering af udbytte**
   - Er det din vurdering af SMV har opnået vækst i form af

    - Ny viden til produkt/kundegrundlag/forretningsudvikling/vækst
    - Ny viden i form af indsigt, selvforståelse, handlekraft/vækst
- Hvad ser du, som SMV og forskers største/mest afgørende indsats?
- Hvad tror du, SMV og forsker ser som din mest afgørende indsats?
- Har du selv fået ny viden ud af samarbejdet? Uddyb!
- **Ser du facilitators rolle som central heri – lige som GTNV-projektet?**

8. Din nye erfaring med videnssamarbejde

- Hvordan ser du denne erfaring med facilitering i forhold til dine tidligere erfaringer?
- Giver GTNV dig anledning til metodiske overvejelser?
- Hvad, mener du, skaber de bedste muligheder for innovation og vækst i vidensamarbejde?
- Er du interesseret i at bidrage i et lignende forløb igen?

9. Andre ting, du ønsker at fremhæve?

Appendix D

This appendix includes the interview guides for the pilot study on case *Alpha Bakery* (in Danish) followed by the *warm-up* and *follow-up* questionnaires (in Danish).

Interview guide (CEO, Alpha Bakery)

Introduktion til interview:	Jeg vil meget gerne tale med dig om tre hovedtemaer, som er Vidensamarbejde, Intermediaries (mellemmænd), og Open Innovation. Jeg vil spørge ind til hvad du disse koncepter betyder for dig og virksomheden, og spørge ind til hvordan I praktiserer det i jeres hverdag og hvad I har af erfaringer på disse områder.			
Område	**Interviewer questions**	***Type***	**Opfølgende spørgsmål**	**Dimensions**
Viden-samarbejde	Hvad forstår du ved 'vidensamarbejde'?	*Con-ceptual*	På hvilke niveauer? Forskning, udvikling, innovation, videnudveksling?	*Meaning*
	Hvorfor vidensamarbejder I?	*Factual*	Hvilke former har får vidensamarbejde har I indgået? (metoder)	*Methods*
	Hvornår har I sidst samarbejdet med en videninstitution? Og hvor ofte?	*Factual*	Flere af gangen? Med samme institution eller forskellige?	*Activity level*
	Hvem I virksomheden samarbejder med videninstitutionerne? Og hvem samarbejde I med? (forsker, studerende, konsulenter)	*Factual*	Er det en højtuddannet? Ansat med videnpilotordningen?	*Education level*
	Fortæl om en succes og/eller fiasko (vidensamarbejde)	*Nar-rative*	Hvad gjorde det til en succes/fiasko? Har du selv deltaget i samarbejdet?	*Perception of interviewee*
	Hvad har I fået ud af vidensamarbejdet? Hvad var udbyttet, efter din mening, hvis ikke noget konkret produkt? Hvad er jeres fremtidige forventninger? Spiller penge en rolle?	*Factual*	Har det haft længere varende effekter? Hvilke? Vil I samarbejde i fremtiden?	*Learning, effects, outcomes*

Intemediaries (mellemmand)	Hvordan opstod kontakten til videninstitutionen?	*Factual*	Har I selv opsøgt kontakten eller blev I kontaktet udefra? Blev I kontaktet af videninstitutionen? Hvem kontaktede jer?	*Initial contact*
	Fik I 'hjælp' til at finde partner/videninstitution?	*Factual*	Matchmaking, evt.	*Intermediation (intial contact)*
	Fik I 'hjælp' til at samarbejde?	*Factual*	Uddyb venligst til hvilke opgaver eller aktiviteter.	*Inter-mediation (during)*
	Spillede denne aktør (mægler) en signifikant rolle?	*Factual*		*Importance of inter-mediation (opinion)*
Open innovation	Har du hørt om 'Open Innovation'? Hvad forstår du ved 'Open Innovation'?	*Con-ceptual*	*(in-bound, out-bound, coupled/co-creation)*	*Meaning*
	Kan du give nogle eksempler for hvordan I praktiserer Open Innovation?	*Factual*	Har I en innovationsstrategi, vision og mission?	*Practices, routines and path*
	Hvor i innovationsprocesserne inddrager I eksterne aktører/videninstitutioner?	*Factual*	Idea-udvikling, projekt-specifikt, markedsføring/nye markeder?	*Process*
	Hvordan søger I viden?	*Factual*	Kender I jeres behov? Kan du give nogle eksempler? (Internet, konferencer, innovationsnetværk)	*Knowledge acquisition*
	Hvordan omdanner i ekstern viden til intern viden? Har I processer for at understøtte denne transformering for at få viden ind i virksomheden?	*Factual*	Kan du give et eksempel? (møder, workshops)	*Knowledge trans-formation (inter-nalisation)*
	Hvordan omdanner i viden fra samarbejdet eller eksterne aktører til produkter?	*Factual*	Kan du give et eksempel?	*Knowledge exploitation*

Interview guide (group interview: COO and Innovation Manager, Alpha Bakery)

Introduktion til interview:	Jeg vil meget gerne tale med jer om nogle hovedtemaer, som er Open Innovation (innovationsprocesser) – med fokus på jeres samarbejde og aktiviteter med universitet/AU/SI, IBC, IBA, designskolen, etc. (vidensamarbejde), og om eksterne kontaktpersoner (mellemmænd) Jeg vil spørge ind til hvordan I praktiserer det i jeres hverdag og hvad I har af erfaringer på disse områder.			
Område	**Interviewer questions**	***Type***	**Opfølgende spørgsmål**	**Dimensions**
Viden-samarbejde	Hvad forstår I ved 'vidensamarbejde'?	*Con-ceptual*	På hvilke niveauer? Forskning, udvikling, innovation, videnudveksling?	*Meaning*
	Hvorfor vidensamarbejder I?	*Factual*	Hvilke former har får vidensamarbejde har I indgået? (metoder)	*Methods*
	Hvornår har I sidst samarbejdet med en videninstitution? Og hvor ofte?	*Factual*	Flere af gangen? Med samme institution eller forskellige?	*Activity level*
	Hvem I virksomheden samarbejder med videninstitutionerne? Og hvem samarbejder I med? (forsker, studerende, konsulenter)	*Factual*	Er det en højtuddannet? Ansat med videnpilotordningen?	*Elcation level*
	Fortæl om en succes og/eller fiasko (vidensamarbejde)	*Nar-rative*	Hvad gjorde det til en succes/fiasko? Har I selv deltaget i samarbejdet?	*Perception of interviewee*
	Hvad har I fået ud af vidensamarbejdet? Hvad var udbyttet, efter din mening, hvis ikke noget konkret projekt? Hvad er jeres fremtidige forventninger? Spiller penge en rolle?	*Factual*	Har det haft længere varende effekter? Hvilke? Vil I samarbejde i fremtiden?	*Learning, effects, outcomes*
Intemediaries (mellemmand)	Hvordan opstod kontakten til videninstitutionen?	*Factual*	Har I selv opsøgt kontakten eller blev I kontaktet udefra? Blev I kontaktet af videninstitutionen? Hvem kontaktede jer?	*Initail contact*

	Fik I 'hjælp' til at finde partner/videninstitution?	*Factual*	Matchmaking, evt.	*Inter-mediation (intial contact)*
	Fik I 'hjælp' til at samarbejde?	*Factual*	Uddyb venligst til hvilke opgaver eller aktiviteter.	*Inter-mediation (during)*
	Spillede denne aktør (mægler) en signifikant rolle?	*Factual*		*Importance of inter-mediation (opinion)*
Open innovation	Har I hørt om 'Open Innovation'? Hvad forstår I ved 'Open Innovation'?	*Con-ceptual*	*(in-bound, out-bound, coupled/co-creation)*	*Meaning*
	Kan I give nogle eksempler for hvordan I praktiserer Open Innovation?	*Factual*	Har I en innovationsstrategi, vision og mission?	*Practices, routines and path*
	Hvor i innovationsprocesserne inddrager I eksterne aktører/videninstitutioner?	*Factual*	Idea-udvikling, projekt-specifikt, markedsføring/nye markeder?	*Process*
	Hvordan søger I viden? (som person, som virksomhed)	*Factual*	Kender I jeres behov? Kan I give nogle eksempler? (Internet, konferencer, innovationsnetværk)	*Knowledge acquisition*
	Hvordan omdanner i ekstern viden til intern viden? Har I processer for at understøtte denne transformering for at få viden ind i virksomheden?	*Factual*	Kan I give et eksempel? (møder, workshops)	*Knowledge trans-formation (inter-nalisation)*
	Hvordan omdanner i viden fra samarbejdet eller eksterne aktører til projekter?	*Factual*	Kan I give et eksempel?	*Knowledge exploitation*

Warm-up questionnaire

Hvem har I samarbejdet med?

- Universiteter
- Professionshøjskole (VIA)
- GTS-instituttet (teknologisk institut, Alexandra, etc.)
- Erhvervsakademier
- Offentlige forskningsinstitutioner
- Andre:

Har I samarbejdet med flere af gangen?

- Ja
- Nej

Kender du til videnkupon- eller videnpilotordningen?

- Ja
- Nej
- Kun videnkupon
- Kun videnpilot

Har virksomheden deltaget i videnkupon-ordning?

- Ja
- Nej

Har virksomheden deltaget i videnpilot-ordning?

- Ja
- Nej

Har I en udviklings- eller innovationsafdeling?

- Ja
- Nej

Er virksomheden en del af et innovationsnetværk eller klynge?

- Ja
- Nej

Angiv virksomhedens fortrukne længde på et innovationsprojekt i samarbejde med en forsker (i måneder)?

- < 6 mdr.
- 6-12 mdr.
- ca. 12-18 mdr.
- ca. 18-24 mdr.
- 24 mdr.<

Follow-up questionnaire

Introduktion
I følgende spørgeskema stiller jeg uddybende spørgsmål inden for områderne:

- Projektforløb og udfordringer
- Udbytte af projekterne
- Motivation
- Eksterne personers rolle
- Ledelsens rolle

Spørgsmålene er rettet mod at få et dybere indblik i, hvordan I samarbejder med videninstitutioner.
[….]

Vidensamarbejde: Projektforløb og udfordringer
'Hvordan samarbejder Easyfood med eksterne aktører fra videninstitutioner'

Projekt	**Projektnavn** ***(7 projekter i alt; én for hvert projekt)***
Hvem samarbejder I med? *(deltagere: videninstitution(er), andre aktører)*	Skriv venligst svarene i denne kolonne
Hvordan opstod kontakten/projektet? **Og hvem er tovholder?** *(hvem tog initiativ til projektet)*	
Hvem i Easyfood deltager i projektet? *(titler)*	
Hvordan arbejder I sammen? *(mail, telefon, møder, Skype-møder, etc.)*	
Hvor og hvor ofte mødes I? ***Eller hvor ofte kommunikerer I?*** *(f.eks. i virksomheden, på videninstitutionen, neutral grund, mm.)*	
Har I *interne* udfordringer med projektet? **Hvis ja, hvilke.** *(uddyb venligst)*	
Har I *eksterne* udfordringer med projektet? **Hvis ja, hvilke.** *(uddyb venligst)*	
Hvor ofte drøftes projektet internt? *(i projektteamet, med andre medarbejdere)*	
Hvor lang tid varede eller hvornår forventes projektet at afslutte? *(mdr., år, forventet afslutning)*	
Er projektet støtteberettiget? **Hvis ja, hvor vigtig er støtten til gennemførelsen af projektet?** *('videnkupon', anden offentligt støtte)*	

Vidensamarbejde: Udbytte
'Hvad har Easyfood fået ud af projekterne'

Projekt	**Projektnavn** ***(7 projekter i alt; én for hvert projekt)***
Hvilket udbytte har Easyfood fået af projektet? *(giv eksempler på udviklede produkter/kapabiliteter, etc.)*	Skriv venligst svarene i denne kolonne
Hvilket *indirekte* udbytte har projektet givet? *(f.eks. inspiration, relationer, etc., uddyb venligst)*	
Hvad har I lært af at deltage i/gennemføre projektet? *(giv gerne eksempler)*	
Har projektet givet anledning til andre/efterfølgende projekter? *Hvis ja, beskriv kort.*	

Motivation
'Hvad driver Easyfood – hvorfor samarbejde med videninstitutioner'

Deltagelse i projekter/videnmiljøer	**Motivation**
Hvad er det, der driver Easyfood til at deltage i *projekter* med videninstitutioner? *(giv gerne eksempler)*	Skriv venligst svarene i denne kolonne
Hvad er det, der driver Easyfood til at deltage i *videnmiljøer/netværk*? *(giv gerne eksempler)*	

Vidensamarbejde: Eksterne personers rolle
'Hvilken rolle spiller eksterne kontaktpersoner'

Eksterne personer i videnmiljøer	
Har Easyfood eksterne kontaktpersoner i videnmiljøer, som virksomheden kan trække på? *(Hvis ja, skriv venligst i hvilke miljøer og på hvilke videninstitutioner)*	Skriv venligst svarene i denne kolonne
Har kontakten til den eksterne/de eksterne skabt værdi eller vigtige forbindelser? *(Hvis ja, giv gerne eksempler)*	
Har kontakten til den eksterne/de eksterne givet Easyfood muligheder, som den ellers ikke ville have haft? *(Hvis ja, uddyb venligst)*	

Vidensamarbejde: Ledelsens rolle
'Hvilken rolle spiller Easyfoods ledelse'

Ledelsens rolle samt antal højtuddannede	
Hvilken rolle spiller Easyfoods ledelse i vidensamarbejde? *(uddyb venligst)*	Skriv venligst svarene i denne kolonne
Hvor stor en rolle spiller Easyfoods ledelse i udvælgelse, deltagelse og udarbejdelse af projekter med videninstitutioner? *(uddyb venligst)*	
Ligger aktiviteterne i vidensamarbejde-regi (projekter/netværk) tæt på eller langt fra Easyfoods strategi? *(uddyb venligst, giv gerne eksempler)*	
Hvor mange af Easyfoods ansatte har en bachelor eller højere grad? *(cirka tal)*	
Hvor mange af de højtuddannede deltager i vidensamarbejde? *(cirka tal; i alt, ikke nødvendigvis pr. projekt/netværk)*	

Tusind tak for hjælpen! ☺

Appendix E

Appendix E describes the methods applied in *chapter 1* for the statistics in *section 1.2* and qualitative interviews with findings integrated in *section 1.4*. The first interview guide (in Danish) is also included.

***Method:** 1.2. An empirical overview of collaborative innovation in Denmark*

The quantitative methods used in *section 1.2* are statistics from secondary data sources. The datasets are extracted from the innovation database of 2010 from *Statistics Denmark* that collects data through the Community Innovation Survey sent out to thousands of firms in Denmark on a yearly basis (Statistics Denmark, 2013). The intended aim of the statistics is to illustrate the scope, nature, and impact of Danish firms' innovation (Statistics Denmark, 2013). Included in these results are firms self-reported innovation activities in the years of 2008, 2009, and 2010.

The data on SMEs (*n=8775*) is derived from the innovation database at Statistics Denmark and results were given via the *SAS system* in the format of 'FREQ Procedure' with weighted frequencies and percentages. Statistics Denmark defines an SME in regards to the number of employees – firms with fewer than 250 – as stated in Article 2 of the ANNEX in the EU recommendation 2003/361.

Indicator variables – or dummy variables – were created for 'collaboration with GTS-institutes', 'collaboration with University/HEI', 'collaboration with Private R&D-firms', and 'collaboration with Public research institutions' (i.e., *samviden)*. In addition, two new variables were created (i.e., *samviden_more*): One variable to indicate whether the SME has collaborated with at least one of the external knowledge actors; and, the second variable, as an extension of the previous variable, indicates how many of the external knowledge actors the SME has collaborated with.

Sources of uncertainties (limitations) include the firms' ability (self-reporting) to distinguish between the various types of innovations, insecurity in determining when an innovation is *an innovation*, or identifying innovation activities undertaken in the firm in the period under review.

Method: *1.4. Introducing a conceptual framework for facilitating SME-university collaborations*

To gain an understanding of the process of facilitating interaction in the GTNV-model, four key informants from the group of actors in the regional program.

Expert interviews (in-depth and semi-structured) were conducted early spring 2013 with three of the operators and one project initiator from the Central Region of Denmark: two face-to-face interviews, one Skype-interview, and one telephone-interview. Each interview lasted approximately one hour with follow-up dialogues via e-mail. Three of the interviews were recorded (except the telephone-interview) and contents were analyzed to comprehend the meaning of actions in relations to the GTNV-model as described by the interviewees (e.g., Kvale and Brinkmann, 2009). An interview protocol was used with iterations after each interview, in order to get a more profound overview of their model, its stages, and what they intended to achieve with it.

The main focus of the interviews were *the perceived gap* between industry and academia, the factors indicating barriers or challenges, and how these could be reduced or overcome with the facilitation of the innovation process for university-industry interaction. After the first interview with the project initiator, the conversation highlighted the possibility of grouping barriers constituting the perceived gap between industry and university into *human-based* and *system-based barriers*, and this was integrated into the following interviews for further discussion.

First interview guide (in Danish)

Introduktion (ca. 5 min)

1. Hvad er dit navn? Hvad arbejder du med til daglig? Hvad er dine primære erfaringer med vidensamarbejde? (kort beskrivelse)

2. Forklar, kort og i store træk, hvad Genvej til Ny Viden er – og formålet? Hvad er din 'rolle'?

3. Hvilke konkrete opgaver har du arbejdet med i "vidensamarbejde-regi"?
   (Genvej og andre samarbejder med virksomheder eller offentlige myndigheder)

Udfordringer for videnudveksling (ca. 5 min)

4. Hvilke barrierer eller udfordringer ser du som værende de mest markante i vidensamarbejde?
   (nævn gerne 3 barrierer/udfordringer)

5. Hvad skal der til for at overkomme disse barrierer?

"Gab" mellem universiteter og virksomheder (ca. 10 min)

6. Oplever du et "gab" – for eksempel kulturforskelle eller andre forskelle – mellem de to verdener (universiteter og virksomheder)? Hvis ja, er det positivt eller negativt for vidensamarbejdet? Hvorfor?

7. Hvad skal der til for at formindske gabet – eller forbedre samarbejdet – mellem videninstitutioner og virksomheder?

8. Er den menneskelige interaktion en udfordring? Hvorfor/hvorfor ikke?

9. Hvilken betydning kan udfordringerne have på innovationsprocesserne mellem de to parter? (Open Innovation)

Vidensamarbejde – generelt og metoder (ca. 10 min)

10. Hvilke typer af vidensamarbejde er mest effektive, efter din mening? (kort- eller langsigtede projekter/samarbejde)

11. Hvilken metode for vidensamarbejde ser du som værende "den mest effektive metode"? (set fra en universitetsvinkel)

12. Hvilke typer virksomheder har tendens til at samarbejde med videninstitutioner? I Genvej til Ny Viden?

13. Hvad er virksomhedernes generelle syn på initiativ for samarbejde med videninstitutioner (for eksempel, Genvej)? Opfylder det virksomhedernes behov for ny viden og kommercialisering af nye produkter eller servicer?

14. Hvad får virksomhederne ud af Genvej til Ny Viden? Er Genvej anderledes end andre initiativer for vidensamarbejde? (hvorfor/hvorfor ikke)

Initiativtager (ca. 5 min)

15. Kender du til andre initiativer eller netværk med succes inden for vidensamarbejde?

16. Set udefra, oplever du et "push" fra universiteter på virksomheder; med andre ord, at initiativet for vidensamarbejde kommer fra universiteter?

17. Hvad skal der til for at virksomheder henvende sig til universiteter og videninstitutioner for at samarbejde?

Andet (XX min)

Ordet er frit

Appendix F

Appendix F is the five 'theme cards' used in the *tuning-in session* of the co-design workshop as a warm up for the Object Game. The quotes on the 'theme cards' are in Danish, and the following five themes are Knowledge-based collaboration (*Vidensamarbejde*), Chemistry (*Kemi*), Dialogue & Interaction (*Dialog & interaction*), Knowledge (*Viden*), and Innovation (*Innovation*). These quotes are selected from cases *Alpha, Beta,* and *Gamma*, and the quotes are as they appeared on the theme cards, with key words highlighted as inspiration for the participant discussion. This participant discussion is summarized into key points, which are addressed in *section 1.5 (table 1.1)*, and parts of the discussion is paraphrased in *Appendix G*.

Temakort 1

(Viden)samarbejde

”Lad os lige tage fat i ordet ’samarbejde’, så er det noget der vender **to veje**. [….] Vi arbejder også sammen med nogle andre virksomheder, hvor de kan noget vi ikke kan. Vi kan ikke alt. […] Vidensamarbejde behøves ikke kun at være offentlig-privat. Man kan sagtens, i min optik, være privat-privat – eller offentlig-offentlig for den sags skyld. Der skal bare være noget **vilje** med.”

”Det er at få nogle samarbejdspartnere som har en **anden viden** end vi har. I det her tilfælde er et mere teoretisk viden, hvor vores den er mere praktisk. Og ved hjælp af at man **udveksler informationer**, så kan man opnå nogle **synergier**, som kan give noget nyt.”

”Så har det selvfølgelig også været afgørende, kan man sige, at vi havde et **fælles interessepunkt**. […] Man er nødt til at være åbent overfor at forskere også sidder og siger, ’what’s in it for me? ’ Skal vi bare aflevere vores viden og så er det det, eller, der skal være en gensidig **win-win** i det, et eller andet sted.”

Nøgleord:

To veje… Vilje… Anden viden… Udveksling… Synergi… Fælles interessepunkt… Win-win

Temakort 2

Kemi

”[S]amarbejde, det handler om **respekt** om den andens ståsted, og **forståelse** for den andens ståsted, og forståelse for den andens person – den andens virkelighed. Og kemi er bare så vigtigt.”

[Det er en] kombination af kemi og kompetencer. […] Det der har været helt afgørende for samarbejdet, det har været kemien. Så det er der ingen tvivl om. Derigennem den **sparring** og **innovation**, der ligesom opstår, når ellers kemien er god.”

” Kemi. […] Men det er ikke kun i sådan et projekt, men på mange andre ting, at hvis man ikke har en god kemi, og så især når man nu er fra **to forskellige miljøer**, hvor man har **fordomme**, så er der meget, der afhænger af de mennesker, der deltager. […] Skal man opnå noget succesfuldt, så stiller det krav til begge parter, at man ikke skal sige, sådan her plejer vi altid at gøre, men at man er **åben** overfor nye impulser.”

Nøgleord:

Respekt… Forståelse… Sparring… Innovation… To forskellig miljøer… Fordomme… Åben(hed)

Temakort 3

Dialog & Interaktion

"[J]eg tror at en dialog, den kræver at man er **på samme sted** og at man er **åben for forandringer**. Så jeg tror faktisk at det er det vigtigste. Hvis vi skal tage det bedste fra begge verdener, det får vi jo kun ved at udveksle informationer gennem dialog, og kan man ikke få den dialog til at køre, jamen så mister man for meget, efter min mening, og så opnår man ikke resultaterne. [….]

Der skal være en **forandringsparathed på begge sider**. Ligesom at de, der var teoretikere, de skal acceptere at man som praktiker måske har en anden tilgang til ting. Så jeg tror, at forandringsparathed, det er noget af det vigtigste."

"[Vi] foretrækker **face-to-face**. Det giver klart den bedste interaktion – det er der ingen tvivl om. Skype er til noget faktuelt. Data i en form – [PowerPoint eller Excel] – så man kan gå igennem og diskutere fakta. Til en lidt mere **innovativ proces** er face-to-face klart at foretrække."

Nøgleord:

På samme sted… Åbenhed for forandringer… Forandringsparathed … Face-to-face… Innovativ proces

Temakort 4

Viden

" Der er to elementer i det – eller der er egentlig flere. Den ene er **videnoverførsel.** Det er ikke al viden du kan skrive ned. Der er bare den viden, som opstår i **kommunikationen** imellem os. Den anden del er den viden, som [forskerne] havde i PowerPoints, som de brugte i andre sammenhænge. Så er der den viden, der **opstår i fællesskab**, i forbindelse med forsøg. Den viden har vi **forankret**."

" [Det er] en alternativ måde at arbejde på. Vi er jo typisk praktikere. Hvis vi blev part med teoretikere, så kunne det godt være vi kunne få den berømte **synergi** frem – at en plus en giver mere end to. [….] [D]et har **skabt den viden**, om at arbejde mere systematisk, og det er noget du kan bruge i alle ting, selvom det er noget helt andet det drejer sig om. **Systematik**, det er sådan en væsentlig ting."

" [H]vis det er, at vi ikke bliver ved med (…) at **få ny viden ind**, så bliver det bare forældet. Og så bliver vores **investering** – og vi har brugt rigtig, rigtig mange timer på det – så er det jo væk."

Nøgleord:

Videnoverførsel… Kommunikation… Fællesskab… Forankring… Synergi… Skabe viden… Systematik… Få ny viden ind… Investering

Temakort 5

Innovation

"[V]i **kombinerer viden** på forskellig vis for at få nogle løsninger, som giver mere mening for dem, der skal bruge det. […] Vi tolker det som evnen til at sikre at de rigtige idéer bliver til virkelighed. [….] [I]nnovation, det er jo at kombinere eksisterende ting på geniale måder. […] Det her med innovation, eller at være innovativ, det bliver typisk, for mange, så bliver det sidestillet med at være **kreativ** – og det er jo noget helt andet."

"[I]nnovation [er] '**udvikling**'. At man **ændrer** tingene – for virksomheden – til en mere positiv måde. Og det kan være på mange ting. […] At du kunne få flere mulige kunder. Det kunne være at du kunne lave et produkt, der kunne det samme, men er mere simpelt, og tjene endnu flere penge. […]

Men det skal jo give noget **værdi** et eller andet sted i værdikæden, ellers er der ikke noget ved at innovere. Den eneste grund til at innovere, hvis det ikke gav værdi, det er hvis der kommer nogen **udefra** – det kan være noget **lovgivning** – at så kunne man blive nødt til at lave innovation på et produkt eller en proces, selvom det ikke egentlig bidrog med noget ny værdi."

Nøgleord:

Kombinere viden… Kreativitet… Udvikling… Ændring… Værdi…. Udefra (lovgivning)

Appendix G

The passages of this section are paraphrases of the actors' responses and discussion (translated from Danish) with an outset in five theme cards in the order discussed in the *tuning-in session* of the workshop with the Object Game – a design game developed for the specific purposes of reflecting upon the collaborative innovation projects.

The actors in case *Alpha* are the *CEO* and *Broker*, and in case *Beta,* the *Creative Director* and *Professor* (e.g., academic researcher). The discussion was audio and video recorded, transcribed (in Danish), and then translated and paraphrased in English.

Five theme cards – a participant discussion

Theme card #1 – (Knowledge-based) Collaboration

CEO, Alpha: Collaboration is a reciprocal process that flows best when both parties benefit from the knowledge exchange. This is done in order to achieve the famous synergy, where one plus one equals three rather than two.

Knowledge flowed both ways. The firms has a practical approach and that is reflected in this, whereas academic researchers had a technical approach and act accordingly. The greatest issue is the prejudices between the two environments. Production workers ask, "What should we use them for? They only know what is in the books!" Academic researchers thought they could improve the production process by 20 times. However, they realized that it probably was not as bad as they had thought, and there was not that much they could have done to improve it.

Creative Director, Beta:

I want to talk about *willingness*. In all projects, one needs to feel that the other party wants this, to prioritize it, and to have time for it. We had a tough time starting this project since there were not many academic researchers who could contribute to the project and had time, too, and who was willing to prioritize it. Thus, one needs to want it, and it applies everywhere.

There are prejudices and cultural differences between the different institutions and research areas. We come with the practical part, and we have not read as many thick books. The academic researchers contribute with the theoretical aspects. The aim was to combine it, and I think we succeeded.

Professor, Beta: I want to pinpoint *great reciprocity*. As [Creative Director, Beta] says, there was willingness from *Company Beta* to allocate and make time for this project and invest in it – both with time and hours. *Company Beta* also came with interesting cases and examples, so I also learned something from this. I did not just bring along the thick theory books, which I should explain to *Company Beta,* but they also came with knowledge that I could use, so I learned, too. From this perspective, there was a tremendous amount of reciprocity.

Theme card #2 – Chemistry

Creative Director, Beta:

'Good chemistry' is when you communicate and talk to each other, when you *can* talk to each other, when you understand each other, and when you are able to be in the same room. Whom you collaborate with does not have to be a World Champion – just a Danish Champion – and if the chemistry is there, then you can reach even higher, than if it were someone you could not talk with. Because then you will not get anything out of it. Thus, it is better to spar with the Danish Champion.

Professor, Beta: I think there are two levels to this. Both parties are committed to the common matter. It is about respect for disciplines, and respect for agreements. The 'good chemistry' evolves if you have fun together. You feel that you are a collaboration, which is not merely a contract, but you also see the people. The formalities need to be in order, and the informalities, too.

CEO, Alpha: I also want to tag along on *respect* for each other, and having the ability to play on the other playing field and follow the rules there. For example, the academic researchers were good at talking to those on the production floor and ask, "How do you see things?". I imagined the academic researchers in dark suits with ties, very rigid, and then you would not have come far. Essentially, it is about mutual respect.

Theme card #3 – Dialogue & Interaction

Broker, Alpha: We took the car and drove to Germany to visit the academic researchers on their playing field, to meet them face-to-face, especially when the other party is in another country, talks another language, and has a different culture. It is easier to collaborate online once you have met.

CEO, Alpha: It is easier if you have met face-to-face once, then it is easier to talk on the phone afterwards. If you never meet, then it is more difficult. Maybe it is because your brain is imagining, "whom am I actually talking to?" Skype and videoconferences can be a half-solution that you might succeed with sometimes. In a longer or more extensive project, it is good with face-to-face.

Creative Director, Beta:

I think that about 70 percent of our communication is non-verbal. This means that in order to work well together, you have to be able to see each other. Skype is fine, but it is just not good enough. You have to sit together and talk to each other. Otherwise, you might as well send e-mails back and forth, and I might as well just read the articles online. Meeting face-to-face regularly, for me personally, it has been very, very important.

Professor, Beta: If you meet regularly, face-to-face, then you can do things via phone and Skype. You know a lot more about how the other person acts, when he or she says *this and that* on the phone. You have gotten to know each other. Many things will not be misunderstood as easily, as if you had not met the other person before. Face-to-face is the foundation.

Broker, Alpha: *Open to change* and *readiness to change*. I think it is important when you engage in this type of project, that the firm is ready to – at some level – is ready for changes. That you change during the process. Some have the attitude that 'we have already tried that' and 'we know how to do this'. The moment that changes one's perspective… that is amazing to experience. *CEO of Company Alpha* has been a frontrunner and supported this all the way – and that has moved some and changed their perspective.

Professor, Beta: As an academic researcher it is important to be ready for change. One should not engage in this type of collaboration with the attitude and thought that 'here I come with a lot of knowledge, and I will deliver some of it, but not all of it', and then go home and leave the firm to figure it out themselves. One should be attuned to change along the way.

Out of the thought of *transfer*, where someone has a lot and someone has little, and he who has a lot gives to he who has little. I do not believe in this. It is not interesting. It is interesting – and this is where reciprocity comes in – when someone with a lot and the other also has a lot. Different disciplines collaborate.

Theme card #4 – Knowledge

CEO, Alpha: Knowledge in itself is worth nothing. It is only the application of knowledge, which is worth something.

Creative Director, Beta:

This project is not finished for us. It is knowledge, and we need to continue building on it, all the time. We now have a foundation that we can build on. We have the systematic approach and the model that we want to keep developing. We need to be aware that all of a sudden, something new might happen, and we would have to incorporate that, too. It is not a static 'thing'.

CEO, Alpha: Our collaboration was fun. We thought that we could use academic knowledge to improve our process. But it turned out, that the academic researchers learned from us. They did not have the specific academic knowledge for this. However, they taught us something else – a systematic approach.

Creative Director, Beta:

[Talking to CEO, Alpha] The knowledge that you have in-house, you wonder how good it is in relation to the academic researchers and in relation to what your competitors have. You do not really have a 'measurement stick' for that. Then, it is actually very good to talk to the academic researchers and find out that you are at par – and that is great to know!

Broker, Alpha: It is also a good thing for the employees to get a pat on the back!

CEO, Alpha: One of the things that we found out is that in fact we do know how to do many things as practitioners. It is just a matter of keep trying and trying and trying. In general, if we need to solve a problem ourselves, we need perhaps five attempts, but if we collaborate with those, whom have a theoretical knowledge, then we might make it is two attempts. This is also an important factor – it is cost saving, and at the same time, you find the solution quicker.

Broker, Alpha: One of the production workers, he said that, 'we do not need to know everything – in the future we could also ask others', since there are some who know something we do not. He was actually one of those who changed perspectives during the process, from being close-minded to being open toward finding knowledge elsewhere.

CEO, Alpha: When we talk about knowledge sharing, then some are not willing to share their knowledge because it gives them a certain status. If you share your knowledge with everyone, then you lose that status. Unfortunately, some more than other are not pleased with sharing.

Theme card #5 – Innovation

Creative Director, Beta:

When you are working with innovation or development, it has to make sense. The majority of projects initiated are not completed. That is a great waste of time and money. Many initiate projects based on a good idea, and then it gets derailed. You have to be able to run those projects. That is when willingness is important – not only in the project group but in the whole organization.

There is a great waste of money on strange projects. I often see people who spend a great amount of money on creative rooms where they can get the good ideas. However, they are not willing to spend money on educating people to be able to use the room.

The combination of knowledge – existing knowledge, bits and pieces – that we can connect. It is super important and essential to work together with academic researchers and experts, who just know a little more than you do yourself. It is super interesting, as a person, to learn something new every time we run projects – we do that a lot.

Professor, Beta: There is an aspect of change in innovation. In development, there can be something, which gradually evolves, whereas in innovation, there is change – from before to after. There is something new introduced in a context. That is the *nova* part of innovation, right. To bring something new to the context, and thus more than development. It is something different from being creative. Being innovative is new creation or new formation that also has value – or purpose.

CEO, Alpha: In the best LEAN-mindset, what we do has to have value. If it does not create value – for the customer or others – than we should not do it. That is the driver in everything we do. I do think that the word *innovation* is used in many different ways, because it is a buzzword. Everyone says you need to innovate, if you want to ride the wave.

Professor, Beta: There is some magical thinking about innovation: if we have an agenda that try to promote innovation, then richness will come along. Politicians have this magical thinking. However, it takes more than that.

Appendix H

Appendix with items and game materials of the *Object Game*

Storybuilding

Co-rating of objects

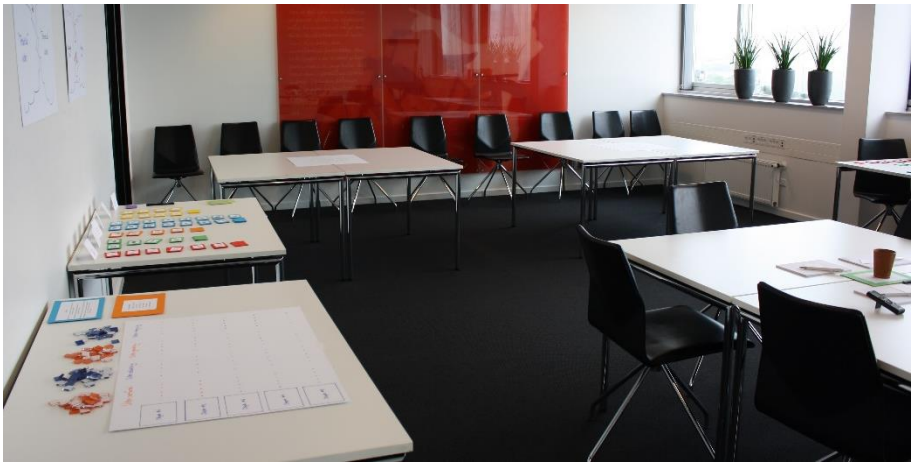
Workspace of the co-design session

Table in the middle for 'tuning-in' session (not part of the Object Game)

Tables up against the walls: one table for co-rating, and one table for placing the story-cards

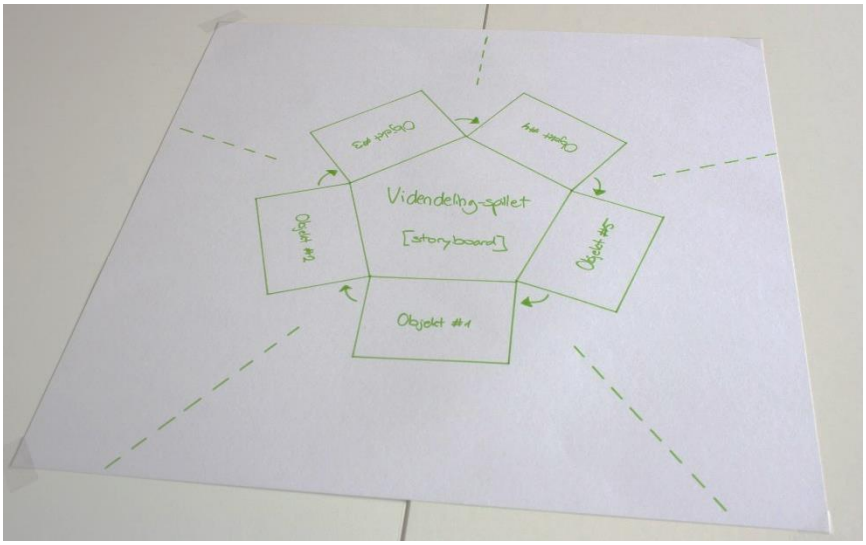
Storyboard on a separate table (bottom right)

Storyboard with Story-building (top left)
Story-cards on a separate table (bottom right)



Co-rating (bottom left), Story-cards (table behind co-rating),
Story-building (tables in the far back), and center table for tuning-in (right)

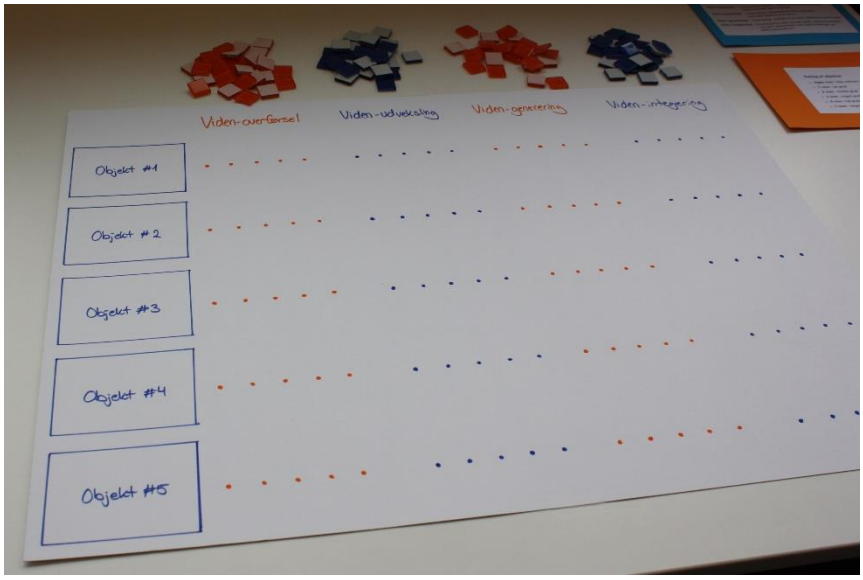
Items in *Story-building*: Storyboard and story-cards



Storyboard

Story-cards

Items in *Co-rating of objects*: platform, definitions and rating system



Platform for co-rating of objects

Cards with definitions and rating system

List with story-cards (Danish and English)

Hvem? (røde kort)	**Who? (red cards)**
Direktør	Director (CEO)
Forsker(e)	Researcher(s)
Facilitator (ekstern)	Broker (external)
Projektleder (ekstern)	Project Manager (external)
Team medlemmer (virksomhed)	Team member (firm)
Medarbejdere (virksomhed)	Employees (firm)
(Blanke røde kort)	(Blank red cards)
Hvor? (grønne kort)	**Where? (green cards)**
Universitet	University
Virksomhed	Firm
Mødelokale	Meeting room
Produktionslinje	Production line
Laboratorie	Laboratory
(Blanke grønne kort)	(Blank green cards)
Hvordan? (orange kort)	**How? (orange cards)**
Face-to-face	Face-to-face
Mails	E-mails
Skype	Skype
Telefon	Telephone
(Blanke orange kort)	(Blank orange cards)
Hvad? (blå kort)	**What? (blue cards)**
Excel	Excel
Powerpoint	Powerpoint
Word	Word
Database	Database
Projektbeskrivelse	Project proposal
Tidsplan (milepæle)	Time schedule (milestones)
Timebrug	Time spent
Forsøg (resultater)	Test/experiment (results)
CAD-CAM	Computer-aided design and manufacturing
Proces	Process
Model	Model
Prototype	Prototype
Produkt	Product

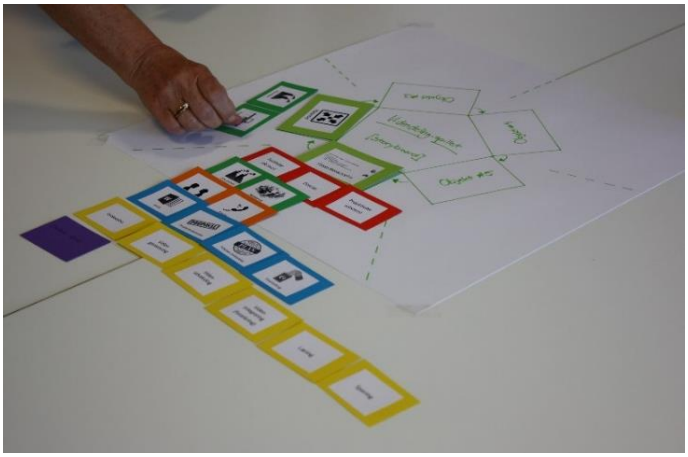
Software	Software
(Blanke blå kort)	(Blank blue cards)
Hvorfor? (gule kort)	**Why? (yellow cards)**
Viden-integrering	Knowledge integration
Viden-generering	Knowledge generation
Viden-udveksling	Knowledge exchange
Viden-overførsel	Knowledge transfer
Innovation	Innovation
Sparring	Sparring
Inspiration	Inspiration
Læring	Learning
(Blanke gule kort)	(Blank yellow cards)
Hvornår? (lilla kort)	**When? (purple cards)**
(Blanke lilla kort)	(Blank purple cards)

Appendix I

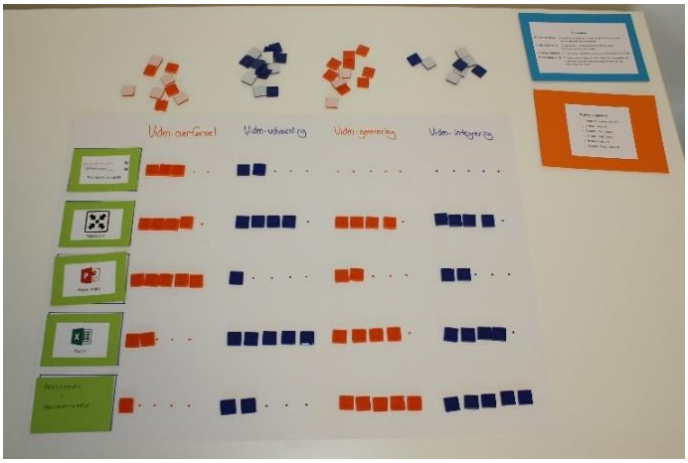
In the *reflections session* of the workshop with the *Object Game* (*Videndelingsspillet*), the participants evaluated the game. The participants were the CEO (*direktør*) and Broker (*facilitator*) from case *Alpha* and the Creative Director (*kreativ direktør*) and Professor of communication in case *Beta*. This appendix presents selected quotes from the evaluation *in Danish*.

Evaluering af Videndelingsspillet

"Spil 1" *(Story-building)*



"Spil 2" *(Co-rating)*



Det positive…

"Jeg synes det er fint, og jeg synes at det er rart, at I **visualiserer**. Det betyder meget for den verden, jeg befinder mig i, at der er nogle kort på. Det virker meget bedre end at skrive en rapport. **Det her [spil 1] synes jeg er godt**."

– Kreativ direktør, Beta (servicevirksomhed)

"Jeg synes faktisk at det har været **meget givende og få lov til lige at reflektere over projektet** på den måde her. Nu er det er stykke tid siden – det er over et år siden vi sluttede. I og med at vi heller ikke kom op og skændes om nogle ting. Der har vi stadigvæk den samme forståelse af det. Men det var faktisk lidt sjovt lige at reflektere over projektet på den måde. **Så det har det været godt til**."

– Facilitator (ekstern projektleder), Alpha

"Noget af det sværeste når man arbejder med projekter, både internt og eksternt, det er **forventningsafstemning**. Hvis man laver sådan et kortspil her, hvor man til det første møde […] lægger de her kort, sådan at de giver mening for virksomheden og forsker. Altså, lægge puslespillet inden – **det er sådan her vi prøver at designe processen og det er det her, der er vigtigt**."

– Kreativ direktør, Beta (servicevirksomhed)

"[…D]et her ville være rigtig godt, hvis det er et projekt, hvor der er **flere forskellige deltagere**. Fordi det er her man kommer til at snakke om, 'Skal vi egentlig kommunikere face-to-face eller per mail?' – 'Hvordan?' – **Det vil vi blive mindet om, at det skal vi altså have med**."

– Professor i kommunikation, Beta

"[…M]ålet er, lige meget hvad man foretager sig, så skal man have det der ***loop*, hvor man når hele vejen rundt** – og der er det tit at man lige mangler det sidste stykke. Det er både i projekter og det kan være andre ting, hvor man ikke lige får det sidste erfaringsudveksling. "

– Direktør, Alpha (fremstillingsvirksomhed)

"En gennemgående fejl, der sker rigtig mange steder, det er at man kører nogle projekter og så sætter man dem i søen, og så tager man ikke [tid] til at snakke om, **hvad har vi egentlig lært af det her, eller hvad har vi oplevet**. Jeg synes også at det var super fedt det her!"

– Kreativ direktør, Beta (servicevirksomhed)

"Jeg synes at det er meget fint. Spil nummer 2 er måske det vigtigste spil, men det bliver man 'primet' til via spil nummer 1. Så det synes jeg er **en god pædagogisk måde at gribe det an på**. Hvis vi var blevet sluppet løs med [spil 2] uden [spil 1], så havde resultatet været anderledes.

Det havde også været mindre brugbart, fordi nu har vi været igennem øvelsen herovre [i spil 1]. **Så det synes jeg er en oplagt måde at gøre det på.**"

– Professor i kommunikation, Beta

"Jeg tænker i hvert fald at det gav **god dynamik** at vi er i det samme rum. Men det kan godt have noget at gøre med, hvilken virksomhed man kommer fra, og også de personer der måske er her, at det fungerer fint."

– Facilitator (ekstern projektleder), Alpha

"Jeg skal lave kick-off på et nyt projekt, og **jeg fik lige noget inspiration til at lave nogle ting.** […Der] er i hvert fald nogle ting, jeg ved, jeg skal have med på min agenda."

– Facilitator (ekstern projektleder), Alpha

"Det er altid spændende at se **nye måder at visualisere ting på**. For eksempel, her i sidste spil [rating af objekter], **se hvor vigtig hver fase var**. Der er det her en fin måde at gøre det på."

– Direktør, Alpha (fremstillingsvirksomhed)

Det, der kan forbedres…

"Det der nok er vigtigt, hvis I vil arbejde videre med det, det er at I får defineret de her lidt mere abstrakte vidensbegreber (peger på *hvorfor*-kortene). De kan jo godt, for nogen tror jeg, virke meget abstrakte, fordi hvad er forskellen på *videnoverførsel* og *videnintegrering*? Fordi, der (peger på spil 2) har I listen, hvor man kan slå det op. Og det kan godt være, at hvis vi går den her igennem (peger på spil 1), at vi måske har lavet nogle fejl med *videnintegrering*. Der var en teknisk ting, at for vores, der lå videnudveksling før denne… Men for nogen kan det være virkelig abstrakte begreber. Så det skal enten gives et andet navn, eller det skal forklares før spillet går i gang."

– Professor i kommunikation, Beta

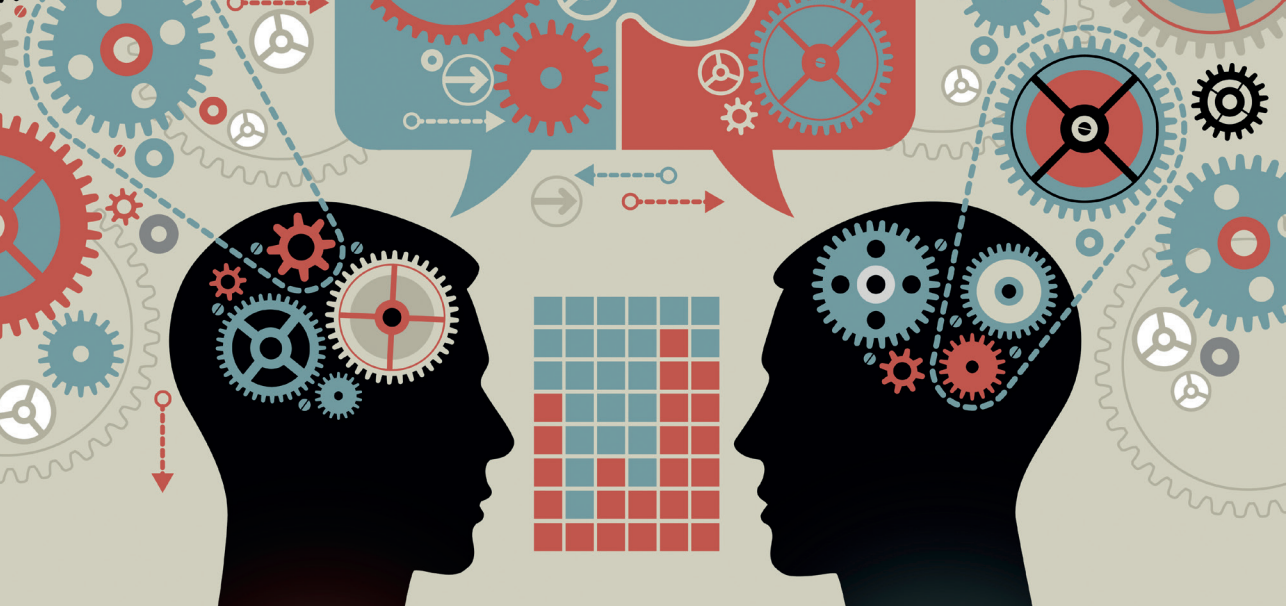
[Dialog]

Direktør (Alpha): [J]eg synes den forklaring du brugte der (spil 2) – at envejs, tovejs, ny generering, forankring – den kunne flere nok forstå og være enige om definitionen. Og det kunne have givet mening af have den til kortene derovre (spil 1).

Professor (Beta): Jeg tror nogen vil simpelthen stå af.

Direktør (Alpha): Ja, det tror jeg også.

Professor (Beta): Her er det ikke så nødvendigt, fordi det er personer (peger på *hvem*-kortene). Det kan vi godt forestille os. Og her er det alt sammen visualiseret (peger på kort med billeder). Og så 'hvorfor', egentlig det én af de vigtige, det bliver så ikke visualiseret. I stedet for går man over i en meget forhøjet abstraktionsgrad. […]



SUMMARY

How do SMEs collaborate with Academia? This is the focal point of this dissertation. Firms collaborate with academia through different mechanisms, depending on the purpose of the interaction. The mechanism studied is *collaborative innovation projects* that are coordinated and facilitated in a Danish regional program. The purpose of these projects is to create growth in SMEs via new knowledge creation, strategic change, and innovation.

Collaborative innovation is the process in which two or more knowledge bases interact and combine their experiences, capabilities and ideas, which may occur through *projects*. The PhD dissertation is a qualitative research study based on multiple case studies. An exploratory design game – the *Object Game* – is designed, developed, and applied in a workshop setting. Findings from the case studies are integrated in the design game, with the purpose of exploring the role of objects, and functions as a research tool and a reflective tool.

The PhD study explores the roles of *brokers*, *capabilities*, and *objects* in making knowledge *flow* between the two knowledge bases of SME and Academia. The findings take an important step in shaping and defining (new) *collaborative boundary practices* to be applied in other contexts where actors from different knowledge bases and boundaries interact, share and create knowledge – ultimately leading to strategic change and innovation.

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