Topic

How firms learn in NPD networks: The 4S model

Abstract

This paper examines how firms learn in new product development (NPD) networks. While existing research in business and industrial marketing has significantly advanced our understanding of learning within single firms and in dyadic relationships, our knowledge of inter-firm learning across direct and indirect business relationships in NPD networks remains limited. We address this limitation by conducting multiple case study research to develop a more holistic understanding of learning in NPD networks that is captured in the proposed 4S model. Drawing on an integrated theoretical perspective and the empirical results of three case studies, we propose that firms engage in iterative cycles of *syndicated*, *situated*, *selected* and *synergised* modes of learning in NPD networks.

Keywords: Inter-firm Learning; New Product Development Networks; Direct and Indirect Inter-firm Relationships; Qualitative Case Study Research; Abductive Logic; Systematic Combining.

1. Introduction

While the top 1,000 companies globally grew investments in innovation at a 6% compound annual growth rate between 2012-2017, marking it as one of the highest business priorities, very few companies revealed to have a rigorous approach for managing the innovation process (Accenture Research Report, 2018). Indeed, while product innovation is considered a critical determinant in firm performance, managing the development process remains as a decisive challenge determining success or failure (Financial Times, 2017). Particularly, to increase the success of new product development (NPD), practitioners have devoted much interest to building relationships and securing mutual benefits with other firms. Significant evidence (see e.g. Leenders and Dolfsma, 2016; Baker et al. 2016; Badir and O'Connor, 2015; Schilling and Phelps, 2007; Johnston and Paladino, 2007) exists to suggest that NPD can be largely enhanced through inter-firm learning with external partners. Given that learning with external partners plays an essential role for new product success, it is critical to know how this is managed in the NPD process. This is the focus of our paper.

Research over the past 20 years has shown that the mobilisation of external partners in NPD can improve a firm's performance and competitiveness (Knudsen, 2007; Croom, 2001; Powell et al., 1996). As firms form and maintain relationships with each other, they weave a network of direct and indirect relationships to gain and share access to resources and know-how. This allows firms to mitigate uncertainties embedded at each stage of the NPD process (Reid and De Brentani, 2004; Tzokas et al., 2004; Cooper et al., 2004; Powell et al., 1996). Although the importance of such endeavours has been long recognised (e.g. Ahuja, 2000; Gulati and Gargiulo 1999; Powell et al., 1996; Owen-Smith and Powell, 2001; Knudsen, 2007), the relevant literature is limited in at least two important aspects.

First, while existing research in business, innovation and industrial marketing has significantly advanced our understanding of learning within single firms and in dyadic relationships (Peters et al., 2017; Möller and Halinen, 2017; Hagedoorn and Duysters, 2012; Borgatti and Halgin, 2011), our knowledge of inter-firm learning across direct and indirect business relationships remains relatively limited (Peters et al., 2017; Najafi-Tavani et al., 2018). In existing literature, the concept of 'networks' is used to describe webs of direct and indirect relationships between organisational actors who are connected through resource ties and activity links (Håkansson and Snehota, 1995; Aarikka-Stenroos and Ritala, 2017; Möller

and Halinen, 2017). Second, with the strengthening of the open innovation model (Chesbrough, 2012; West and Bogers, 2014; Laursen, 2012), many inter-firm networks have become powerful NPD incubators. However, how exactly learning happens in such networks along the stages of the NPD process over time has largely remained unexplored. Most of the relevant research either fixates on understanding one particular stage (such as the fuzzy front end) or remains rather general (see e.g. Veldhuizen et al., 2006; De Brentani and Reid, 2012). An integrated, stage-wise understanding of inter-firm learning in the NPD process is largely neglected in the existing literature. This is surprising, as Leenders and Dolfsma (2016: 127) noted "because successful innovation often requires firms to get knowledge, ideas, financial and other resources from 'the outsider' and bring them into the firm, where they need to be routed to the right place at the right time."

The aim of this paper is to explore the process of how firms learn through direct and indirect relationships at each stage of NPD. To do so, we first review the dominant theoretical approaches to understanding firm learning and innovation in the context of NPD. Next, we present a systematic comparison of the three main theoretical approaches, including the knowledge-based, the practice-based, and the relational governance-approaches to learning at the dyadic and network levels of analysis (as presented in Table 1). We demonstrate that most of the existing understanding of interfirm learning hardly moves beyond the firm or dyadic levels of analysis.

To address this limitation, this research draws on multiple case-study research to investigate how firms learn through direct *and* indirect relationships from the idea generation stage to the more regimented product development and launch stages of the NPD process (see e.g. Veldhuizen et al., 2006; Tzokas et al., 2004). In this paper, we use the term 'NPD networks' as organisations involve a large variety of (direct and indirect) partners in their NPD process – such as users, customers, suppliers, distributors, and intermediaries; and engage in a varied set of collaborative arrangements, such as alliances, joint ventures, or collaborative research (see e.g. Nambisan and Sawhney, 2011; Leenders and Dolfsma, 2016). To define our unit of analysis and network boundaries, we identified three cases that evidenced successful completion of an NPD project[1] within the past three years.

[1] A complete NPD project is defined as a process from idea generation to product launch (see e.g. Cooper and Kleinschmidt, 1995).

The key contribution of this paper rests in a refined understanding of inter-firm learning in NPD networks that we capture in the 4S model. The *syndicated, situated, selected* and *synergised* modes of learning constitute an iterative, open-ended learning process in NPD. In contrast to existing, linear stage-gate approaches to understanding NPD processes that drew predominantly on single firm or dyadic levels of analyses, the 4S model presents a more holistic understanding of how firms learn through direct *and* indirect relationships over time.

This paper is structured as follows. Section Two summarizes the theoretical background, followed by a discussion of our research design in Section Three. Section Four provides a discussion of the case study findings in light of relevant theory and presents our research propositions. The conclusion in Section Five articulates the research implications, outlines the limitations of this research and proposes directions for further research.

2. Theoretical Background

2.1 The NPD process

Over the years, NPD research attracted significant attention from scholars who probed the secrets of NPD success factors and examined the process of transforming products from an idea to launch stage (e.g. Nelson and Winter, 1977; Dosi, 1988; Brown and Eisenhardt, 1995; Powell et al., 1996; Reid and De Brentani, 2004; Cooper et al., 2004; Knudsen, 2007; Aarikka-Stenroos and Ritala, 2017). To this end, firms' learning is primarily viewed as a process of iterative mitigation of uncertainty that takes place from managing the 'fuzzy front end' to the more systematic post deployment and launch cycles (Tzokas et al., 2004; Cooper and Kleinschmidt, 1995; Lievens and Moenaert, 2000). For instance, Zahay et al. (2018) and Aarikka-Stenroos et al. (2017) propose three broad stages of NPD, including: (1) *idea generation*, entailing idea exploration, idea screening and business analysis; (2) *product development*, covering development and testing; and (3) *product launch* containing the commercialisation of the developed product. While the NPD process entails different stages, existing research tends to either propose a rather generic approach to learning in NPD processes (e.g. Veldhuizen et al., 2006; Zahay et al, 2018) or concentrate on untangling the 'fuzzy front-end' stage (e.g. Gassmann and Schweitzer, 2014; De Brentani and Reid, 2012).

For example, Veldhuizen and colleagues (2006) study information processing in the NPD process and shed light on the new product outcome. Similarly, Zahay et al. (2018) focus on managing knowledge throughout the NPD process and conclude that firms may do well in collecting and disseminating knowledge but ignore the examination of knowledge application. The quest to understand the 'fuzzy front end' has attracted most significant research attention and is considered the earliest stage of 'idea generation' in the NPD process (Smith and Reinertsen, 1991). In this regard, researchers (e.g. Kim and Wilemon, 2002; Chen et al., 2011; Stevens, 2014) suggest that firms should acquire and assimilate information and knowledge from external sources to generate commercially successful ideas. Quinn (1985) and Utterback (1994) notice that ideas are often generated from the external business networks; and De Brentani and Reid (2012) highlight the importance of inter-firm learning at the 'fuzzy front end' for both, incremental and discontinued, new products. And yet, research throughout the remaining stages of the NPD process remains underdeveloped. To address this limitation and refine our understanding of how firms learn in direct and indirect relationships *throughout* the NPD process, we review and build on three streams of research: The knowledge-based approaches to learning (Section 2.2.1); the practice-based approaches to learning (Section 2.2.2) and the relational-governance based approaches to learning (Section 2.2.3).

2.2 Inter-firm learning in direct and indirect relationships

2.2.1 Knowledge-based approaches to inter-firm learning

In their seminal work, Cyert and March (1963) propose three important steps to learning: to ask the right questions at the right time (i.e. acquisition or recognition); to absorb the answers, share understanding of implications (i.e. transmission or assimilation); and to act decisively (i.e. application). This framework is well-accepted by scholars advancing the knowledge-based approach to learning (e.g. Argyris and Schön, 1978; Huber 1991; Sinkula et al., 1997; Blackler 1995; Cook and Brown, 1999; Beamish and Berdrow, 2003; Valtakoski, 2017) and has significantly informed the literature on organisational learning processes. However, the learning process becomes more complicated when the unit of analysis extends from single firm to inter-firm learning. That said, knowledge creation and transfer in an inter-firm relationship requires more sophisticated activities to manage interactions and coalitions (Halme 2001; Argote and Ingram, 2000; Larsson et al., 1998). In research on

organisational knowledge creation, the interplay between tacit and explicit knowledge has attracted significant research attention (Zollo and Winer, 2002; Nonaka, 1994; Polanyi, 1966). Other advances within the knowledge-based approaches to learning include the concepts of 'exploitative' and explorative' learning (March, 1991), which explain how firms learn either from the refinement and extension of existing knowledge or from the experimentation with new alternatives. Building on the study of knowledge-based approaches to learning at the dyadic level of analysis, attention to the network level of analysis increased, which resulted in the development of literature on knowledge networks (see e.g. Carnabuci and Operti, 2013; Phelps et al., 2012; Pullen et al., 2012). For example, Håkansson et al. (1999) stress how knowledge networks enhance the learning of the firm. Pyka (2002) and Akgün et al. (2006) propose the concept of the 'cross-fertilisation effect' to depict a fusion of knowledge in network settings. Notably, Phelps et al. (2012) offer a framework that helps to organise the knowledge networks research into the categories of knowledge outcomes, knowledge network properties and level of analysis, calling for more research on knowledge networks.

While the knowledge-based literature provides rich insights into knowledge transfer and a firms' learning process, it has been criticised for its ignorance of 'practice' by practice-based theorists (e.g. Wenger, 2000; Brown and Duguid, 1991) who argue that learning is essentially a collective social practice and is highly relevant to inter-firm learning. As a result, an alternative stream of research emerged that has been termed the 'practice-based' approach to learning, which is discussed next.

2.2.2 Practice-based approaches to inter-firm learning

Scholars adopting a practice-based approach view learning as a distinct type of social practice (e.g. Lave and Wenger, 1991; Brown and Duguid, 1991). Such a conceptualisation of learning provides an epistemological conduit between organisational *knowledge* and organisational *knowing* (Blackler, 1995; Cook and Brown, 1999). It highlights the importance of studying process dynamics and organisational routines to understand the intricacies of inter-firm learning (Felin et al., 2012; Pentland and Feldman, 2005). In this sense, practice-based scholars emphasise that managerial learning processes are intrinsically social and collective phenomena. For example, Brown and Duguid (1991) and Lervik et al., (2010) suggest firms' learning is situated in work practices and is generated under conditions

of practical engagement. Similarly, Wenger (2000:225) suggests that 'the success of organisations depends on their ability to design themselves as social learning systems and also to participate in broader learning systems such an industry, a region or a consortium'. Bångens and Araujo (2002) identify three important learning approaches: The *learning-by-using* approach enhances social influence effects (particularly under high uncertainty); the *learning-by-doing* approach leads to a convergence in attitudes or actions; and the *learning-by-interacting* helps to establish a knowledge equilibrium through interaction (also see Popova-Nowak and Cseh, 2015). In short, the practice-based approach views firm learning as an act of participation by collectively developing understanding and mutual engagement between learning actors (Wenger et al., 2002; Roberts, 2006; Hotho et al., 2014).

Despite its practical value, the practice-based approach to learning is commonly criticised in two ways: A first concern is that current practice-based studies rarely explicitly consider social structures beyond communal or firm boundaries (see e.g. Pattinson et al. 2016). Although some researchers have acknowledged that a firm's learning may draw on broader network structures that requires further study (e.g. Hotho et al., 2014; Roberts, 2006), exactly *how* learning processes are affected by these broader network structures remains unclear. A second concern is related to the limited attention to understanding the impact of relational issues such as conflicting and disruptive power relations (e.g. Vaast and Walsham, 2009; Macpherson and Clark, 2009), trust and social capital (e.g. Dayan and Di Benedetto, 2010; Land et al., 2012) on firm learning. As such, the complexity and potential impact of relational issues on inter-firm learning processes deserves separate attention, as discussed below.

2.2.3 Relational-governance approaches to inter-firm learning

Learning through inter-firm cooperation can and does occur successfully. It, however, can also be a difficult, frustrating, and often misunderstood process (Inkpen, 1996; Larsson et al., 1998; Tóth et al., 2018). While firms learn in order to reduce uncertainty, the state of uncertainty also increases the opportunity for actors to shirk, cheat, or otherwise engage in opportunism without being caught (Schoorman et al., 2007; Krickx, 2000; Ouchi, 1980). Tensions such as incongruity between (or among) actors' aims and unclear communication can generate discomfort and distrust in inter-firm learning (Tóth et al., 2018; Abosag et al., 2016).

Fundamentally, relational trust is an essential property to create a belief between learning actors that knowledge sharing increases joint value more than that, which could be created individually or with other partners. For example, Selnes and Sallis (2003) note that inter-firm learning depends on both learning actors' willingness to cooperate and trust each other in joint learning activities. It is believed that relational trust helps to overcome communication barriers, facilitates knowledge sharing and increases the use of knowledge transfer (Seppänen et al., 2007; Tóth et al., 2018). However, trust is more complex to establish and sustain in complex networks. The presence of ill-coordinated communication channels across direct and indirect relationships can become a source of tension. For example, in studying tension in value co-creation networks, Tóth et al. (2018) highlight the ripple effect that occurs when tension triggered by one or a few actors can destabilise the wider network.

Despite the importance of these insights, existing research on how firms address issues of tension and trust in inter-firm learning remains imperfectly understood (Tóth et al., 2018; Hoholm and Olsen, 2012). A promising avenue to address this limitation is offered by research into *relational and formal* contracting (e.g. Mouzas and Ford, 2012; Carson et al., 2006). Existing research (e.g. Carson et al., 2006; Argyres and Mayer, 2007) suggests that the combination of relational (e.g. trust and social norms) and formal contractual (e.g. formal control by contract) governance can contribute to effectively mitigating uncertainty and decreasing risks of opportunism and freeriding. As Mouzas and Ford (2012:1251) suggest "the formality of contracts is not external to the substance of business interactions, but a way of articulating, facilitating and simplifying the complexity of business interactions".

To provide a synthesised understanding, we consolidate the review of the knowledge-based, practice-based and relational-governance approaches to learning in Table 1 by clustering existing research according to its dominant levels of analysis: the dyadic and network levels, from which a conceptual framework is proposed (Figure 1). It highlights that the existing understanding of inter-firm learning that is relevant to our research of learning in the NPD process is mostly confined to studies exploring learning in direct inter-firm relationships.

<Insert Table 1 near here>

3 Methodology

To address the limitations in existing research on inter-firm learning in the NPD process as discussed in previous sections, we conducted multiple case study research (Welch et al., 2011; Piekkari et al., 2010) to empirically investigate how firms manage inter-firm learning in direct and indirect relationships throughout the NPD process.

3.1 Research design and case selection

We ground our case study research in the critical realist epistemology (Bhaskar, 1978; Sayer, 1992; Easton, 2010). This decision enabled us to investigate complex, context-sensitive processes with the explanatory rigour in theorising and conceptually representing this process (Welch et al., 2011; Ryan et al., 2012). Case study research is particularly suitable to address our objective of refining and developing concepts explaining inter-firm learning in NPD networks, because it allowed us to capture network learning over time as a complex, multi-actor phenomenon that is "difficult to separate from its context, but necessary to study within it to understand the dynamics involved in the setting" (Halinen and Törnroos, 2005:1286). A multiple-case study enables us to reduce the influence of industry type on firm performance and outcomes, leading to greater accuracy of this research.

We applied theoretical and purposeful sampling (Dubois and Araujo, 2007) to select three cases that illustrate how firms manage inter-firm learning in direct and indirect relationships. To achieve this, we used business forums and events to generate relevant cases that satisfied three sampling criteria: (1) The focal firm had to provide evidence of successfully completing an NPD project within the past three years; (2) the project had to be conducted in an NPD network; and (3) the firms were willing to provide the contact details of their direct and indirect partners involved in the NPD project. Specifically, the attended forums and events were selected according to three requirements: The forum or event had to focus on new product development, provide opportunities to network with relevant business actors, and include participants from different industries. An illustrative sample of attended events includes the "Support for New Products and Processes Seminar" hosted by the Scottish Enterprise, the "Business Networking Seminar" hosted by the Scottish Council and the "Opportunities in Next Generation for Power Applications" organised by the European Union. Upon selecting the cases, we used the concept of 'focal nets' (Halinen and Törnroos, 2005; Nyström et al., 2014) to conceptually represent the boundaries of the studied networks

and we used a completed NPD project as a process relevant unit of analysis to address the temporal boundaries of case study research. As a result, three focal firms were selected from three different industries, including e-commerce, energy and tourism:

Focal (Firm) e-Commerce is an independent British supplier of internet product and services for business customers. The company has successfully developed a patented software that provides advanced search engine service and is well accepted in the industry. This search engine software is the unit of analysis (i.e. the focal NPD project) in our study. Case e-Commerce was established by the focal company with its eight direct and four indirect network relationships.

Focal Energy is a mechanical engineering company specialised in engineering services and production equipment for both operators and service companies in the energy industry. With its founders' rich experience in the industry, Focal Energy has successfully developed and launched a new product - a new tool in exploring oil fields (also the unit of analysis of this study) - to tackle a problem that had been an unsolved issue for a prolonged period in the industry. Case Energy was established by the Focal energy with its nine direct three indirect network relationships.

Focal Tourism is founded by two entrepreneurs with an innovative idea. The idea then is turned into a successful product (our unit of analysis) that is used (and purchased) by many well-known hotels to create a range of gift voucher experiences. The product is the first of its kind in the UK. Case Tourism was established by the Focal Company with its eight direct and four indirect network relationships.

Identifying details of the firms had to be anonymised for confidentiality purposes. The comparability of cases was established through using our research question and conceptual framework as common parameters for within- and cross-case analysis. Specifically, we follow the three broad stages of NPD suggested by Zahay et al. (2018) and Aarikka-Stenroos et al. (2017) including (1) idea generation, (2) product development; and (3) product launch to help us categorise and systematise the data sets within and across cases. Synthesising process patterns across three cases offered us a stronger basis for conceptual development and followed exemplary practice in network process research (Bizzi and Langley, 2012; Halinen et al., 2012).

3.2 Data collection

Our primary empirical data comprises 39 semi-structured interviews, observation, company documents and archival records. Systematically triangulating evidence from multiple data sources within and across the cases was a deliberate effort to ensure the dependability, transferability, confirmability and credibility of our findings with the effect of developing a robust conceptual framework and research propositions (Piekkari et al., 2010). Developing a case protocol and semi-structured interview-protocol (available upon request) served the systematic recording of interactions involved in the complex process of inter-firm learning in NPD networks. In order to capture the networked interactions, we placed significant emphasis on conducting interviews with a range of actors involved in NPD at the focal company and their direct and indirect networks partners. Interviews with Product Development Team Leaders, Marketing Directors, Product and Sales Managers or Service Engineers among others lasted between 30 and 90 minutes (Appendix A). In so doing, all interviewees were first provided with a list of potential network partners such as customers and suppliers. Interviewees were then asked to rank the network partners in their markets for the importance to the targeted NPD project (1=not at all important; 5=extremely important), and to describe (a) how the company managed inter-firm learning with important network partners (whom they ranked ≥ 3) in the NPD project; (b) whether there were any issues, such as conflicts and appropriability; and (c) if so, how the issues were managed. All conversations were structured according to the three NPD stages. All interviews were recorded, transcribed and subsequently analysed using NVivo-11. Subsequently, the transcripts were sent to the interviewees for review and revised, if necessary. We complemented interview data with gaining access to relevant material evidence of inter-firm learning, including letters, meeting minutes and project agendas as well as consulting archival records that contained service and organisational records and company collateral.

3.3 Data analysis

We utilised the approach known as 'systematic combining' (Dubois and Gadde, 2002), because it is particularly useful for analysing complex data sets with the objective of theory development (Andersen and Kragh, 2010). Systematic combining rests on applying abductive logic – an intermediate position between deduction and induction – which allowed us to

continuously develop and refine the emerging conceptual framework in relation to our research aim. Considering the limited research available on inter-firm learning in the NPD process, and specifically how this process is orchestrated across direct and indirect relationships, abduction allowed us to achieve increasingly fine-grained conceptual mapping of our empirical data in light of an evolving theoretical framework.

We started with multiple cycles of within-case content analysis to make sense of the transcribed interviews and material evidence, followed by cross-case pattern searching. This involved mapping of network actors within each case and the analysis of multiple inter-firm process-layers within and across the three cases. To manage and analyse our qualitative data set, we used tabulation techniques such as 'clustering' and 'comparison/contrast' for data display and reduction (Miles et al., 2014). We combined the use of open, axial and selective coding in order to identify and assign data-fragments to first and higher-order concepts (Strauss and Corbin, 1998) with counting the frequency of codes (Table 2) to establish relevant code density (Miles and Focalerman, 1994). The emerged higher-order concepts, including the syndicated, situated, selected and synergised modes, form the key pillars for the 4S model explaining how firms learn in NPD networks and are mapped against the three established NPD stages. In Section Four, we present and discuss each concept forming the 4S model in relation to illustrative empirical evidence and existent conceptual work. In order to avoid duplication, condense evidence from three cases and present a conceptual synthesis of the empirical findings, we use thematic cross case analysis (Yin, 2003) to report our findings in the following section.

<Insert Table 2 near here>

4. Findings and Discussion

This section presents the findings and the associated research propositions according to the aggregate themes that emerged from within and cross-case data analysis, which are detailed in Table 3 and illustrated in the 4S model (Figure 2). The 4S model conceptually represents the complex inter-firm learning process in NPD networks, which includes the *syndicated mode*, the *situated mode*, the *selected mode*, the *synergised mode* and the operation of the '*open ended learning loop*', and these are discussed below.

<Insert Table 3 near here>
<Insert Figure 2 near here>

4.1 Syndicated mode of learning: a coordinative spectrum

The 'syndicated mode' depicts the practice of firms' combining and balancing different learning approaches (i.e. exploitative and explorative; past and new knowledge transfer). This syndicated-learning mode expands beyond project, time or firm relational boundaries. Confirming existing research in NPD and specifically the 'customer active' paradigm (Foxall, 1986), our findings repeatedly demonstrate that new product ideas often emerge from learning from customers' problems (e.g. Schweitzer et al., 2018; Di Brentani and Reid, 2012): "*…We learn so much from customers, especially their complaints…when our new product solves their (*customers'[2]*) problem, it is a guarantee of quick cash flow*!' (Focal, e-Commence).

From a knowledge-based perspective, this observation reflects an exploitation approach through the process of knowledge transfer and transformation to facilitate improved, or incremental ideas – a rapid way for customer acceptance and likely commercial success. This observation also echoes prior studies (e.g. Molina-Castillo et al., 2011; Schweitzer et al., 2018; Kim and Atuahene-Gima, 2010), stressing market-related exploitative (refinement-led) learning that largely contributes to feeding the 'fuzzy front end' for new product development.

Nevertheless, exploitative approaches (although relevant for rapid cash flow) only unveil a part of the firms' learning practice. An important phenomenon surfaces in a more explorative approach that manifests in firms' active gathering, cross-fertilising and reconfiguring of knowledge and resources for the purpose of new product development. As one interviewee described: *'…When I brought back some new ideas that I learned from different seminars to my team… we saw a very promising opportunity for our long-term strategy to compete with our competitors. No one has thought about it before, not even our customers…This is how*

[2] The author's own notes are presented in brackets.

this cutting-edge new product idea emerged. But this is not our cash-cow just yet…" (Focal, Case Energy).

When asked where the 'cash cow' was, a 'balanced coordination' is further emphasised: '*…Oh, we need to do both at the same time. On the one hand, we solve our customers' problems to maintain our cash flow. On the other hand, we know we have to develop new ideas for our long-term survival…. See, we are not the company that can only solve customers' existing problems. It is these new ideas that are beyond our customers' expectations that keep us very competitive in this marke*t' (Supplier, Case Energy).

Our data insofar seems to suggest that for rapid cash flow, a traditional approach of exploitative learning (recognise, assimilate and apply) is often employed to generate incremental new product ideas. A more explorative learning approach (gather, cross-fertilise, and create) is likely to be used for cutting-edge new product ideas. Notably, data also suggest that between exploration and exploration, it may not necessarily require a conflicting or trade-off relation as suggested by the resource-based view (March, 1991). Rather, our study seems to indicate that firms apply a *'syndicate approach'* that balances between short-term survival (a rapid cash flow) and long-term growth (generating cutting-edge new ideas). This result coincides with the work of Möller and Halinen (2017:8) who pinpoint that "the level of determination of the value activities is reflected in the specificity of knowledge structures, especially the balance between exploration and exploitation activities". From a practice-based view, it also echoes the work of Brown and Duguid (2001) who suggest 'a coordination practice' between the *discovering* approach (the conventional response to markets) and the *enacting* approach (highly proactive and interpretive response to markets).

Notably, while this syndicated mode is mostly found in the idea management stage (73% of total counts, see Table 2), it is also relevant, albeit to a lesser degree, in the product development (20%) and launch (7%) stages. More importantly, our data highlight that firms' learning in NPD networks does not start from the ideation stage, as most existing literature suggests. Instead, firms actively integrate previous NPD learning. For example, one of the interviewees in the Case Tourism highlighted that:

"*I was approached by Kate* (a pseudonym, Marketing Director of the focal firm) *at a meeting… And she asked if she could come and have some discussions with our people.*

From that, she got a whole lot of information and knowledge of what we previously did – those were what we have learned from c3 (a customer in Case Tourism*) …I guess it's because of Kate. She is from this industry. She knows how to quickly grasp real issues!*" (Customer' supplier, Case Tourism).

Indeed, the learning actors' previous learning and experience (Kate's 15 years industrial experience) play an important role in this learning process. This phenomenon is consonant with the knowledge-based notion in the learning and capability literature, emphasising firm capability is developed through and dependent on past knowledge/experience trajectories (see e.g. Forkmann et al., 2018; Argote and Ingram, 2000; Zollo and Winter, 2002; Teece et al., 1997). This observation is captured in the concept of the 'open ended learning loop' discussed in Section 4.5.

In sum, the above discussion of our findings suggests that firms learn in their NPD networks through a syndicated mode where learning actors combine and balance learning approaches (i.e. exploitative and explorative; past and new knowledge transfer). Equally important, this syndicated-learning mode in NPD networks encapsulates the nature of inter-firm learning that is beyond the boundaries of single projects or a confined timeframe. Therefore, we refer to it as the 'cross-project' and 'cross-timeframe' syndicated learning mode. That is, the more the cross-project (or cross-timeframe) mode is applied, the more successful the idea generation will be. Thus, we propose:

> ***Proposition 1a:*** *The cross-project syndicated learning mode positively impacts the success*[3] *of idea generation in the NPD process.*
>
> ***Proposition 1b****: The cross-timeframe syndicated learning mode positively impacts the success of idea generation in the NPD process.*

[3] Here, we denote 'success' as a success at one stage (e.g. idea generation) that moves to next stage (e.g. product development stage) in the NPD process.

4.2 Situated mode of learning: a co-participation approach

The 'situated mode' captures firms' active engagement in physical and virtual co-participation with direct and indirect network partners to improve mutual *understanding* and overcome learning obstacles. As our attention moves to the product development stage, a key issue is repeatedly mentioned – *understanding*: "*The language they* (the focal firm's supplier) *used was different from the language we used, although we all spoke English. It was very difficult to communicate with them. They found it difficult to understand us, and we found difficult to understand them. This understanding issue could be a big mess*!" (Customer's customer, Focal e-Commence).

Indeed, the traditional knowledge-based concept of turning tacit knowledge explicit (e.g. Nonaka, 1994) illuminates the crucial role of 'understanding' in firm learning. There is a gap between knowledge and knowing (Cook and Brown, 1999). The practice-based view suggests that merely turning tacit or sticky knowledge explicit is insufficient to explain the issue. Instead, understanding must be located in the access to 'collective participation' (Lave and Wenger, 1991), and can be improved in a 'situated' manner (Brown and Duguid, 2001). This observation is illustrated below:

'My goodness, it was very difficult for us to understand their process. It involved customer relationships, accounting and finance, even the legal department…to understand all these, it was a chaos…We just did not understand each other. It is like they were speaking a special language called "finance", and we only understood a language called "marketing" …We need an interpreter..." (Supplier, Case Tourism)

To address the issue of creating a common understanding, the supplier in 'Case Tourism' describes an instance of 'co-participation':

'It was Kate, she asked us currently what we were doing, how we managed vouchers…, all kinds of questions…. And she asked if she could come and work with our people, so she met with the finance department, the marketing department, even our retailers. And sometimes, she even worked with our customers. You see, now Kate is our 'interpreter!' (Supplier, Case Tourism).

The above excerpt illustrates the situated mode, to borrow the concept of situated learning where learning is *situated* in work practices and is generated in the contexts and conditions of practical engagement (Brown and Duguid, 1991; Wenger, 2000; Lervik et al., 2010). The situated mode of learning complements Nonaka's (1994) SECI (socialisation, externalisation, combination and internalisation) theory and Bångens and Araujo's (2002) work on learning-by-doing and learning-by-interacting. It points to a highly interactive and productive engagement that is acquired through the shared learning process. More notably, NPD network learning is managed by a co-participation approach either *physically or virtually* through *direct and indirect* interactive and shared learning engagements. This occurrence appears more frequently in the product development (73% of counts) stage rather than the idea generation (15%) or product launch (12%) stages.

So far, our findings suggest that firms learn in their NPD networks through a physical and virtual situated mode where learning actors engage in physical and virtual co-participation with direct and indirect partners to improve understanding and overcome learning obstacles (as we termed it *situated learning mode*). This mode is essential to the product development stage. That is, the more the situated learning mode is applied, the better the result of the product development will be. We therefore posit:

> ***Proposition 2****: The situated learning mode positively impacts on the success of product development in the NPD process.*

4.3 Selected mode of learning: a secure attachment

The 'selected mode' for secure attachment denotes firms' practice of actively using formal contracts to facilitate learning in NPD, avoid tensions caused by uncertainty and distrust and to secure rights and benefits gained from collaborative NPD. While the phenomenon of co-participation and co-engagement recurrently emerged across all cases, our data continuously remind us that co-participation and engagement are conditional upon a sense that the firm's rights and benefits are protected – *a sense of security*. This security is actively sought and established through the use of formal contracts with direct and indirect partners in the NPD network:

"…*there was a company asking us for solutions. But they were not willing to sign a confidentiality agreement…. So, I just say 'Sorry! We cannot afford that*!' *We never approached them again since then…Without a confidentiality agreement, we just cannot work with any partners at any stage! This is important*." (Supplier's customer, Case Energy).

While some scholars suggest that the use of contracts as a means of 'protection' may hinder knowledge transfer and prevent innovation (e.g. Alexy et al., 2009; Owen-Smith and Powell, 2001); our data support the alternative perspective where using effective formal governance mechanisms such as contracts promotes better NPD performance (e.g. Carson et al., 2006; Mouzas and Ford, 2012): '*No protection contract, no talk! See…new product ideas are our lifeblood. If there is no protection, we will never ever work with any outsiders*…' (Focal, Case e-Commerce).

To this end, prior work (e.g. Dayan and Di Benedetto, 2010; Land et al., 2012) has suggested that social capital (manifested in perceived trust and power) helps to create a more efficient and safer environment that is potentially more conducive to knowledge access, transfer and utilisation. Nevertheless, issues such as tension, conflict or opportunism are too sensitive to be resolved exclusively with reliance on perceived 'trust' in the context of direct and indirect relationships. To this end, our results are in line with Mouzas and Ford (2012) who emphasise the importance of the formality of contracts in business interactions. The formality of contracts seems especially important when knowledge is transferred *beyond* dyadic relationships. Indeed, while a firm can build trust in direct relationships through direct communication and personal experience (Håkansson et al., 1999), relying on trust in indirect relationships where a firm has limited exposure to direct interaction and control, can be problematic (Håkansson and Ford, 2002). In this sense, carefully selecting learning partners and securing the partnership with formal contracting in NPD networks seems essential. We termed it a '*selected mode*' for a secure attachment to depict that learning actors learn with selected network partners, where contractual protection is a premise. Notably, different from other modes, this selected mode emerged throughout *all* NPD stages rather evenly, with 41% at the idea development, 35% at the product development and 24% at the launch stage.

Our findings therefore indicate that firms learn in their NPD networks through a selected mode in which learning actors privilege network partners with formal contractual governance

to avoid tensions caused by uncertainty and distrust. This mode is applied throughout the NPD process. Therefore, we posit that:

> ***Propositions 3:*** *The selected mode positively impacts on the success at all the stages in the NPD process.*

4.4 Synergised mode of learning: a co-evolution configuration

The 'synergised mode' captures firms' co-evolution in NPD that expands beyond the boundaries of time, project and direct inter-firm relationships. In other words, firms engage in 'cross-pollination' that denotes metaphorically the process where firms co-evolve through a 'bee' (e.g. Kate as an interpreter in Section 4.2) that pollinates knowledge not only within the confines of direct relationships or single NPD projects, but across direct and indirect relationships, projects and time. This important phenomenon is well reflected in the Case Energy:

'*Product launch is a complex task for us! We had a client from Saudi* (Arabia) *asking to install this product in order to explore new fields* (for oil). *The installation required us to learn from their* (the Saudi client's) *local supplier in order to ensure the technological compatibility. Then we had to work with their joint venture to make sure there was no legal issue. This took us about one year to make sure everything was in place. But we are happy to have this experience. Now, we have a successful case that we are much likelier to sell our product to other customers in the international market…Interestingly, we found they* (the Saudi client) *also take the idea, having another new product selling in other markets'* (Focal, Case Energy).

This pollination process approximates the knowledge-based concept of 'cross fertilisation' (Akgün et al. 2006) – a similar concept of cross-effect suggested by Pyka (2002), emphasising that companies advance their existing knowledge from transferred knowledge. Yet, our data demonstrate that this learning mode operates beyond the dyadic concept of cross-fertilisation. This is confirmed in Case Tourism, who state:

"*Now when we look back, we actually learn more from launching our product. Each of our customers is different, their needs are different. We learn different things from them*

(customer and customer's suppliers). *Now, when our other customers need any special functionalities for their business, I always provide the best solution for them. It is the learning from so many parties that helped me. Without working in such a way, our business would simply be non-existent*!" (Supplier's supplier, Case Tourism).

The synergised learning mode is complex in that there are two underlying properties. First, when a network actor learns from various network partners, the transferred knowledge is cross-fertilised, but the multidisciplinary knowledge is obtained from multifaceted relationships in the network. For example, the learning between a focal firm (A) and its customer (B) can be a result of the previous learning between customer (B) and its supplier (C). In this case, focal firm (A) not only learns from its direct relationship with (B) but also its indirect relationship with (C). Second, within this pollination process, learning is accumulated from either direct and/or indirect network relationships. The actors' previous experience and knowledge were obtained from other projects therefore intensify a transformation endowment that crosses the boundaries of time, projects and relationship distance.

To our knowledge, this synergised mode of network learning has not yet been addressed in existing research. That is, because the manifestation of the synergised mode expands beyond the boundaries of time, projects and direct relationships, it can generate a total effect of network learning that is greater than the sum of the individual, dyadic or NPD project specific learning effects. We also find that the synergised mode is mostly present at the product launch stage (52%) followed by the idea generation (36%) and the product development stage (12%).

In light of this discussion, our findings imply that firms learn in their NPD networks through a synergised mode where learning actors co-evolve through a synergised manner to cross-pollinate with networked partners for greater value co-creation than the sum of the value created within dyadic relationships. The synergised mode mostly enhances the NPD at the product launch stage. We therefore propose:

> ***Proposition 4****: The synergised learning mode positively impacts on the success of product launch in the NPD process.*

Finally, our identification of the synergised mode reveals another important pattern in our data that we conceptually represent as the '*open ended learning loop*'.

4.5 An 'open-ended learning loop'

As discussed earlier, in seeking a synthesised understanding of how firms learn in NPD networks, we had drawn on the stage process suggested in the NPD literature (e.g. Zahay et al. 2018; Aarikka-Stenroos and Ritala, 2017). This presumed stage process provides us with a framework to systematise our initial findings and analysis of a complex data set across three cases. However, the stage-approach to NPD may need further development in order to capture a more accurate understanding of firms' learning in NPD networks. As one of our focal firms has reflected: *'Our customers would tell us where we can do better next time. Now, when our other customers need any special functions for their business, I understand better and always provide the best solution for them.'*

Our findings suggest that learning in NPD networks manifests as '*an open-ended learning loop'* that characterises network learning as an iterative, continuously evolving cycle with no clear-cut starting and endpoint. As discussed in the above sections, firms' learning in the NPD context is most likely to draw on a firm's learning across different NPD projects, across time and network settings. Therefore, it is highly likely for firms to have different learning modes in place at the same time with different actors. In this sense, we propose that learning in NPD networks does not follow a linear model but rather reflects a *learning loop*. Moreover, although we reported our findings sequentially, discussing each of the '4S' modes, this conceptual segregation shall not deter from the fact that our findings strongly confirm that inter-firm learning in NPD networks preserves a cross-stage and cross-project nature.

Our findings therefore unveil an important yet under-researched phenomenon, that is, inter-firm learning in NPD networks is not linear, but manifests in an iterative, 'open-ended learning loop'. This learning loop is important as it enhances NPD success. Hence, we propose:

Proposition 5: *An open-ended learning loop positively impacts on NPD success.*

5. Conclusions

To improve product development performance in highly competitive markets, deliberately managing learning throughout the NPD process is not optional, but a compulsory action. Yet, while existing research recognised the imperative role of NPD in determining firm performance and survival, our understanding of how firms learn *across* the NPD stages and *beyond* dyadic interactions remained limited. This research provides one of the few ventures that sheds light on this crucial limitation and raises several important theoretical contributions and managerial implications.

5.1 Theoretical contribution

This research is one of very few attempts (to our knowledge) that explicitly engages in developing a systematic understanding of how firms learn across direct and indirect relationships throughout the NPD process over time. This paper has not confined itself to drawing on one theoretical approach to inter-firm (such as the knowledge-based approach) and instead, for the first time, informs our understanding of the whole NPD process with a relevant synthesis of three mature approaches to firm learning, including the knowledge-based, practice-based, and relational governance approaches. This allows for a more conceptually robust and refined understanding of inter-firm learning in NPD networks.

Moreover, building on the synthesis of the relevant literature, this paper advances our understanding of learning at the network level of analysis. Specifically, this paper provides a conceptual model of interfirm learning that responds to research calls for a better understanding of knowledge networks (Phelps et al., 2012). It addresses the ignorance of conflict and power (Vaast and Walsham, 2009) and a lack of a broader network consideration in practice-based theory (Hotho et al., 2014). Equally important, this paper is one of very few (if not the first) studies to provide an empirically grounded analysis of how firms learn throughout the NPD process.

5.2 Managerial implications

While developing new products is a key contributor to firm performance, insights into the actual endeavours involved in managing the whole process of NPD beyond the confines of the single firm or dyadic relationships remain underdeveloped. By offering a conceptual

blueprint for mapping inter-firm learning in NPD networks, our research provides managers and product developers with a clearer approximation of a real-life process than the traditional, stage-gate models. In practical terms, the 4S model highlights the importance for managers to actively leverage past and current NPD project experience across the boundaries of time, project and firm relationships possibly through cross-project teams, cross-participation as well as active management of project documentation.

While our research certainly highlights the benefits to be gained from network-level cross-pollination, it also alerts managers to actively manage the selection of network partners and invest in protection agreements to ensure value creation and appropriation *beyond* dyadic inter-firm relationships. In this regard, this research suggests that formal contractual protection remains one of the key approaches to be applied by managers who face challenges in governing NPD across indirect relationships.

5.3 Limitations and further research

In this study, there are a few methodological and theoretical limitations that lead to several directions for further research. First, while we collected data from three different industries to reduce the influence of industry type on firm performance and outcomes, the generalizability of our findings is limited. Therefore, examining the application and accuracy of the 4S model through larger scale research would benefit the existing body of knowledge on NPD networks. We hope that our research propositions (Section 4) offer useful guidance for future mixed method or quantitative studies to further refine and operationalise the proposed concepts. Second, the complexity of inter-firm learning in the context of NPD raises fertile ground for a more nuanced analysis of the influence and use of relational governance mechanisms such as trust and reliance in promoting inter-firm learning. Our study also opens an avenue for further research to better understand how and when to combine relational and formal contractual governance (Tóth et al., 2018). Finally, it would be vital to understand how firms combine formal and informal contractual governance to facilitate inter-firm learning at each stage of NPD. To this end, the concepts of bounded rationality and contractual incompleteness (Mouzas and For, 2012) are relevant, but the scope of this research precluded a more detailed discussion of these concepts in determining the full potential and limitations of formal contracting particularly in the 'selected mode' of NPD. Using the advances in research on the resource-based view and value appropriation, future

research would benefit from examining how firms access and appropriate joint value and resources from NPD collaborations.

Appendix A

Focal and Networked Companies Profile

INDUSTRY / COMPANY	RELATION TO FOCAL FIRM	NUMBER OF EMPLOYEES	INTERVIEWEE POSITION	GENDER	LENGTH OF INTERVIEW
(e-Commerce) C2E	**Focal Firm**	**25**	**Founder**	**Male**	**90 min'**
c1	customer	200	Product Development Team Leader	Male	55 min'
c2	customer	35	Managing Director	Male	45 min'
s1	supplier	550	Product Manager	Male	30 min'
s2	supplier	69	Sales Manager	Female	30 min'
3p1	3rd party	35	General Manager	Male	45 min'
com1	competitor	200	Product Development Team Leader	Male	55 min'
3p2	3rd party	30	Service Manager	Male	30 min'
jv1	joint venture	80	Engineer	Female	60 min'
c1-1c	customer's customer	300	Marketing Specialist	Male	45 min'
c2-1s	customer's supplier	25	General Manager	Male	30 min'
s2-1s	supplier's supplier	150	Purchasing Specialist	Female	35 min'
s2-2c	supplier's customer	20	Marketing Director	Male	30 min'
(Tourism) C4T	**Focal Firm**	**10**	**CEO and Marketing Director**	**Both Female**	**95 min'**
c1	customer	80	Marketing Manager	Male	30 min'
c2	customer	100	Front Desk Manager	Male	50 min'
c3	customer	150	General Manager	Female	45 min'
s1	supplier	25	Service Manager	Female	55 min'
jv1	joint venture	55	Partner	Male	45 min'
3p1	3rd party	25	Consultant	Female	40 min'
3p2	3rd party	80	Marketing Specialist	Female	60 min'

d1	distributor	50	Marketing Director	Female	50 min'
c1-1c	customer's customer	6	Hotel Chain Manager	Female	30 min'
c2-1c	customer's customer	30	Service Engineer	Male	30 min'
s1-1s	supplier's supplier	5	Engineer	Male	45 min'
s1-2c	supplier's customer	55	Service Manager	Male	35 min'
(Energy) C5O	**Focal Firm**	**50**	**Managing Director - MKG, PD**	**All Male**	**70 min'**
c1	customer	97,000	Operations Engineer	Male	45 min'
c2	customer	108,000	Well Engineer	Male	30 min'
c3	customer	30,000	Technology co-ordinator	Male	30 min'
c4	customer	80,000	Well Ops. Engineer	Male	45 min'
jv1	joint venture	80	Product Manager	Male	60 min'
3p1	3rd party	300	Advisor	Male	50 min'
3p2	3rd party	100	Technology Co-ordinator	Male	30 min'
s1	supplier	30	Production Director	Female	35 min'
s2	supplier	100	Purchasing Manager	Male	45 min'
s1-1c	supplier's customer	10,800	Engineer	Male	25 min'
s1-2s	supplier's supplier	75	Service Engineer	Female	30 min'
s2-1c	supplier's customer	25	Managing Director	Male	30 min'
				TOTAL:	**1,715 min'**

References

Aarikka-Stenroos, L. and Ritala, P., 2017. Network management in the era of ecosystems: Systematic review and management framework. *Industrial Marketing Management, 67*, pp.23-36.

Abosag, I., Yen, D.A. and Barnes, B.R., 2016. What is dark about the dark-side of business relationships? *Industrial Marketing Management, 55*, pp.5-9.

Accenture. 2018. Discover where value is hiding. Accenture Research Report. Accessed October 3rd, 2019 from: https://www.accenture.com/gb-en/insights/consulting/innovation-organizational-change.

Ahuja, G., 2000. The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal, 21(3),* pp.317-343.

Akgün, A.E., Lynn, G.S. and Yılmaz, C., 2006. Learning process in new product development teams and effects on product success: A socio-cognitive perspective. *Industrial Marketing Management*, *35*(2), pp.210-224.

Alexy, O., Criscuolo, P. and Salter, A., 2009. Does IP strategy have to cripple open innovation? *MIT Sloan Management Review*, *51*(1), pp.71-77.

Andersen, P.H. and Kragh, H., 2010. Sense and sensibility: Two approaches for using existing theory in theory-building qualitative research. *Industrial Marketing Management*, 39(1), pp.49-55.

Argote, L. and Ingram, P., 2000. Knowledge transfer: A basis for competitive advantage in firms. *Organizational behavior and human decision processes*, *82*(1), pp.150-169.

Argyres, N. and Mayer, K.J., 2007. Contract design as a firm capability: An integration of learning and transaction cost perspectives. *Academy of Management Review*, *32*(4), pp.1060-1077.

Argyris, C. and Schön, D., 1978. *Organizational learning: A theory of action perspective*. Reading, MA: Addison-Wesley.

Badir, Y.F. and O'Connor, G.C., 2015. The formation of tie strength in a strategic alliance's first new product development project: The influence of project and partners' characteristics. *Journal of Product Innovation Management, 32(1),* pp.154-169.

Baker, W.E., Grinstein, A. and Harmancioglu, N., 2016. Whose innovation performance benefits more from external networks: entrepreneurial or conservative firms? *Journal of Product Innovation Management, 33(1),* pp.104-120.

Bångens, L. and Araujo, L., 2002. The structures and processes of learning. A case study. *Journal of Business Research*, *55*(7), pp.571-581.

Beamish, P. and Berdrow, I., 2003. Learning from IJVs: The unintended outcome. *Long Range Planning*, *36*(3), pp.285-303.

Bhaskar, R., 1978. Realist Theory of Science, the Harvester Press Ltd, Sussex, UK.

Bizzi, L. and Langley, A., 2012. Studying processes in and around networks. *Industrial Marketing Management, 41(2),* pp.224-234.

Blackler, F., 1995. Knowledge, knowledge work and organizations: An overview and interpretation. *Organization Studies*, *16*(6), pp.1021-1046.

Blomqvist K, Hurmelinna P, Seppänen R (2005) Playing the collaboration game right – balancing trust and contracting. *Technovation 25*, pp.497–504.

Bohnet I., and Baytelman Y., 2007. Institutions and trust: implications for preferences, beliefs and behaviour. *Rationality and Society, 19,* pp.99–135.

Borgatti, S.P. and Halgin, D.S., 2011. On network theory. *Organization Science, 22(5),* pp.1168-1181.

Brown, J.S. and Duguid, P., 1991. Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization Science*, *2*(1), pp.40-57.

Brown, J.S. and Duguid, P., 2001. Knowledge and organization: A social-practice perspective. *Organization Science*, *12*(2), pp.198-213.

Brown, S.L. and Eisenhardt, K.M., 1995. Product development: Past research, present findings, and future directions. *Academy of Management Review, 20(2),* pp.343-378.

Carnabuci, G., & Operti, E. 2013. Where do firms' recombinant capabilities come from? Intraorganizational networks, knowledge, and firms' ability to innovate through technological recombination. *Strategic Management Journal*, 34(13): 1591–1613.

Carson, S.J., Madhok, A. and Wu, T., 2006. Uncertainty, opportunism, and governance: The effects of volatility and ambiguity on formal and relational contracting. *Academy of Management Journal*, *49*(5), pp.1058-1077.

Chen, C.Y., 2012. An innovative knowledge management learning cycle by Lego NXT for science education. *International Journal of Innovative Computing, Information and Control*, *8*(1B), pp.791-798.

Chesbrough, H., 2012. Open innovation: Where we've been and where we're going. *Research-Technology Management, 55(4),* pp.20-27.

Cohen, W.M. and Levinthal, D.A., 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), pp.128-152.

Cook, S.D. and Brown, J.S., 1999. Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organization Science*, *10(4),* pp.381-400.

Cooper, R.G. and Kleinschmidt, E.J., 1995. Benchmarking the firm's critical success factors in new product development. *Journal of Product Innovation Management, 12*(5), pp.374-391.

Cooper, R.G., S. J. Edgett, and E. J. Kleinschmidt. 2004. Benchmarking best NPD practices— II. *Research-Technology Management 47 (3*), pp.50–59.

Croom, S.R., 2001. The dyadic capabilities concept: examining the processes of key supplier involvement in collaborative product development. *European Journal of Purchasing & Supply Management*, *7*(1), pp.29-37.

Cyert, R.M. and March, J.G., 1963. A behavioral theory of the firm. *Englewood Cliffs, NJ*, *2*(4), pp.169-187.

Dayan, M. and Di Benedetto, C.A., 2010. The impact of structural and contextual factors on trust formation in product development teams. *Industrial Marketing Management*, *39*(4), pp.691-703.

De Brentani, U. and Reid, S.E., 2012. The fuzzy front-end of discontinuous innovation: Insights for research and management. *Journal of Product Innovation Management*, *29*(1), pp.70-87.

Dosi, G., 1988. Sources, procedures, and microeconomic effects of innovation. *Journal of Economic Literature*, pp.1120-1171.

Dubois, A. and Araujo, L., 2007. Case research in purchasing and supply management: opportunities and challenges. *Journal of Purchasing and Supply Management, 13(3),* pp.170-181.

Dubois, A. and Gadde, L.E., 2002. Systematic combining: an abductive approach to case research. Journal of Business Research, 55(7), pp.553-560.

Easton, G., 2010. Critical realism in case study research. *Industrial Marketing Management, 39(1),* pp.118-128.

Felin, T., Foss, N.J., Heimeriks, K.H. and Madsen, T.L., 2012. Microfoundations of routines and capabilities: Individuals, processes, and structure. *Journal of Management Studies*, *49*(8), pp.1351-1374.

Financial Times, August 2017. The key to innovation is balancing risk and rigour. *Financial Times*, August 14, 2017, p.13.

Ford, D. and Mouzas, S., 2013. The theory and practice of business networking. *Industrial Marketing Management*, *42*(3), pp.433-442.

Forkmann, S., Henneberg, S. C., and Mitrega, M., 2018. Capabilities in business relationships and networks: Research recommendations and directions. *Industrial Marketing Management*, *74*, pp.4-26

Foxall, G., 1986. A conceptual extension of the customer-active paradigm. *Technovation*, *4*(1), pp.17-27.

Gassmann, O. and Schweitzer, F. Eds., 2014. *Management of the fuzzy front end of innovation*. Springer.

Gulati, R. and Gargiulo, M., 1999. Where do interorganizational networks come from?. *American Journal of Sociology*, *104*(5), pp.1439-1493.

Hagedoorn, J., and Duysters, G. 2002. Learning in Dynamic Inter-Firm Networks: The Efficacy of Multiple Contacts. *Organization Studies, 23(4),* pp.525-548.

Håkansson, H. and Ford, D., 2002. How should companies interact in business networks? *Journal of Business Research, 55*(2), pp.133-139.

Håkansson, H. and Johanson, J. 1992. A model of industrial networks. (Chapter 2, pp.28-36). In: B. Axelsson and G. Easton, (Eds). 1992. *Industrial networks: A new view of reality*. London: Routledge.

Håkansson, H. and Snehota, I., 1995. The burden of relationships or who's next. In *IMP Conference (11th)* (Vol. 11). IMP.

Håkansson, H., Havila, V. and Pedersen, A.C., 1999. Learning in networks. *Industrial Marketing Management*, *28*(5), pp.443-452.

Halinen, A. and Törnroos, J.Å., 2005. Using case methods in the study of contemporary business networks. *Journal of Business Research, 58(9*), pp.1285-1297.

Halinen, A., Medlin, C.J. and Törnroos, J.Å., 2012. Time and process in business network research. *Industrial Marketing Management, 41(2)*, pp.215-223.

Halme, M., 2001. Learning for sustainable development in tourism networks. *Business Strategy and the Environment*, *10*(2), pp.100-114.

Hedlund, G., 1994. A model of knowledge management and the N-form corporation. *Strategic Management Journal*, *15*(S2), pp.73-90.

Hoholm, T. and Olsen, P.I., 2012. The contrary forces of innovation: A conceptual model for studying networked innovation processes. *Industrial Marketing Management*, *41*(2), pp.344-356.

Hotho, J.J., Saka-Helmhout, A. and Becker-Ritterspach, F., 2014. Bringing context and structure back into situated learning. *Management Learning*, *45*(1), pp.57-80.

Huber, G.P., 1991. Organizational learning: The contributing processes and the literatures. *Organization Science, 2(1),* pp.88-115.

Inkpen, A.C., 1996. Creating knowledge through collaboration. *California Management Review*, *39*(1), pp.123-140.

Johnston, S. and Paladino, A., 2007. Knowledge management and involvement in innovations in MNC subsidiaries. *Management International Review, 47*(2), pp.281-302.

Kim, J. and Wilemon, D., 2002. Focusing the fuzzy front–end in new product development. *R&D Management*, *32(4),* pp.269-279.

Kim, N. and Atuahene-Gima, K., 2010. Using exploratory and exploitative market learning for new product development. *Journal of Product Innovation Management, 27*(4), pp.519-536.

Knudsen, M. P. 2007. The Relative Importance of Interfirm Relationships and Knowledge Transfer for New Product Development Success. *Journal of Product Innovation Management, 24(2),* pp.117–138.

Krickx, G.A., 2000. The relationship between uncertainty and vertical integration. *The International Journal of Organizational Analysis*, *8*(3), pp.309-329.

La Rocca, A., Hoholm, T. and Mørk, B.E., 2017. Practice theory and the study of interaction in business relationships: Some methodological implications. *Industrial Marketing Management, 60*, pp.187-195.

Land, S., Engelen, A. and Brettel, M., 2012. Top management's social capital and learning in new product development and its interaction with external uncertainties. *Industrial Marketing Management, 41*(3), pp.521-530.

Larsson, R., Bengtsson, L., Henriksson, K. and Sparks, J., 1998. The interorganizational learning dilemma: Collective knowledge development in strategic alliances. *Organization Science, 9*(3), pp.285-305.

Laursen, K., 2012. Keep searching and you'll find: what do we know about variety creation through firms' search activities for innovation?. *Industrial and Corporate Change, 21*(5), pp.1181-1220.

Lave, J.W. and Wenger, E.,1991. Situated learning. Legitimate peripheral participation. *Cambridge University Press.*

Leenders, R. T. A. J., and Dolfsma, W. A. 2016. Social Networks for Innovation and New Product Development. *Journal of Product Innovation Management, 33(2),* pp.123–131.

Lervik, J.E., Fahy, K.M. and Easterby-Smith, M., 2010. Temporal dynamics of situated learning in organizations. *Management Learning*, *41*(3), pp.285-301.

Lesser, E. and Everest, K., 2001. Using Communities of Practice to Manage Intellectual Capital Improving an organization's use of knowledge assets. *Ivey Business Journal, 65(4),* pp.37-43.

Lievens, A. and Moenaert, R.K., 2000. Communication flows during financial service innovation. *European Journal of Marketing*, *34*(9/10), pp.1078-1110.

Macpherson, A. and Clark, B., 2009. Islands of practice: Conflict and a lack of 'community' in situated learning. *Management Learning*, *40*(5), pp.551-568.

March, J.G., 1991. Exploration and exploitation in organizational learning. *Organization Science*, *2*(1), pp.71-87.

March, J.G.,1991. *Exploration and exploitation in organizational learning*. *Organization Science*, 2(1), pp. 71-87.

Miles, M. B., Focalerman, A. M., and Saldana, J., 2014. *Qualitative data analysis: A methods sourcebook.* Sage Publications Ltd, California, USA.

Miles, M.B., and Focalerman, A.M., 1994. (2nd ed). *Qualitative Data Analysis.* Thousand Oaks London- New Delhi: Sage.

Molina-Castillo, F.J., Jimenez-Jimenez, D. and Munuera-Aleman, J.L., 2011. Product competence exploitation and exploration strategies: The impact on new product performance through quality and innovativeness. *Industrial Marketing Management*, *40*(7), pp.1172-1182.

Möller, K. and Halinen, A., 2017. Managing business and innovation networks—from strategic nets to business fields and ecosystems. *Industrial Marketing Management*, *67*, pp.5-22.

Mouzas, S. and Ford, D., 2012. Leveraging knowledge-based resources: The role of contracts. *Journal of Business Research*, *65*(2), pp.153-161.

Mouzas, S., and Ford, D., 2009. The constitution of networks. *Industrial Marketing Management, (38),* pp.495-503.

Najafi-Tavani, S., Najafi-Tavani, Z., Naudé, P., Oghazi, P. and Zeynaloo, E., 2018. How collaborative innovation networks affect new product performance: Product innovation capability, process innovation capability, and absorptive capacity. *Industrial Marketing Management*, *73*, pp.193-205.

Nambisan, S. and Sawhney, M., 2011. Orchestration processes in network-centric innovation: Evidence from the field. *Academy of Management Perspectives*, *25*(3), pp.40-57.

Nelson, R.R. and Winter, S.G., 1977. In search of a useful theory of innovation. In *Innovation, economic change and technology policies* (pp. 215-245). Birkhäuser, Basel.

Nonaka, I., 1994. A dynamic theory of organizational knowledge creation. *Organization Science*, *5*(1), pp.14-37.

Nyström, A.G., Leminen, S., Westerlund, M. and Kortelainen, M., 2014. Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), pp.483-495.

Ouchi, W.G., 1980. Markets, bureaucracies, and clans. *Administrative science quarterly*, pp.129-141.

Owen-Smith, J. and Powell, W.W., 2001. To patent or not: Faculty decisions and institutional success at technology transfer. *The Journal of Technology Transfer*, *26*(1-2), pp.99-114.

Owen-Smith, J. and Powell, W.W., 2004. Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community. *Organization Science,15(1),* pp.5-21.

Pattinson, S., Preece, D. and Dawson, P., 2016. In search of innovative capabilities of communities of practice: A systematic review and typology for future research. *Management Learning*, *47*(5), pp.506-524.

Pentland, B.T. and Feldman, M.S., 2005. Organizational routines as a unit of analysis. *Industrial and corporate change*, *14*(5), pp.793-815.

Peters, L. D., Pressey, A. D., and Johnston, W. J., 2017. Contagion and learning in business networks. *Industrial Marketing Management*, *61*, pp.43-54.

Phelps, C., Heidl, R., & Wadhwa, A. 2012. Knowledge, Networks, and Knowledge Networks A Review and Research Agenda. *Journal of Management*, 38(4): 1115–1166.

Piekkari, R., Plakoyiannaki, E. and Welch, W., 2010. 'Good' case research in industrial marketing: Insights from research practice. *Industrial Marketing Management, 39,* pp.109–117.

Polanyi, M., 1966. The logic of tacit inference. *Philosophy*, *41*(155), pp.1-18.

Popova-Nowak, I.V. and Cseh, M., 2015. The meaning of organizational learning: a meta-paradigm perspective. *Human Resource Development Review*, *14*(3), pp.299-331.

Powell, W.W., Koput, K.W. and Smith-Doerr, L., 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, pp.116-145.

Provan, K.G., Fish, A. and Sydow, J., 2007. Interorganizational networks at the network level: A review of the empirical literature on whole networks. *Journal of Management*, *33*(3), pp.479-516.

Pullen, A. J. J., de Weerd-Nederhof, P. C., Groen, A. J., & Fisscher, O. A. M. 2012. Open Innovation in Practice: Goal Complementarity and Closed NPD Networks to Explain Differences in Innovation Performance for SMEs in the Medical Devices Sector. *Journal of Product Innovation Management*, 29(6): 917–934.

Pyka, A., 2002. Innovation networks in economics: from the incentive-based to the knowledge-based approaches. *European Journal of Innovation Management*, *5*(3), pp.152-163.

Quinn, J.B., 1985. Managing innovation: controlled chaos. *Harvard Business Review*, *63*(3), pp.73-84.

Reid, S.E. and De Brentani, U., 2004. The fuzzy front end of new product development for discontinuous innovations: A theoretical model. *Journal of Product Innovation Management*, *21*(3), pp.170-184.

Roberts, J., 2006. Limits to communities of practice. *Journal of management studies*, *43*(3), pp.623-639.

Ryan, A.M., Täthinen J., Vanharanta, M., and Mainela, T., 2012. Putting critical realism to work in the study of business relationship processes. *Industrial Marketing Management, 41*, pp.300-311.

Sayer, A., 1992 (2nd Ed.). Method in social science. A realist approach. Routledge, London, UK.

Schilling, M. A., and Phelps, C. C. 2007. Interfirm collaboration networks: The impact of large-scale network structure on firm innovation. *Management Science, 53(7),* pp.1113–1126.

Schoorman, F., Mayer, R. C., and Davis, J. H., 2007. An integrative model of organizational trust: Past, present and future. *Academy of Management Review, 32,* pp.334-354.

Schweitzer, F., Palmié, M. and Gassmann, O., 2018. Beyond listening: the distinct effects of proactive versus responsive customer orientation on the reduction of uncertainties at the fuzzy front end of innovation. *R&D Management*, *48*(5), pp.534-551.

Selnes, F. and Sallis, J., 2003. Promoting relationship learning. *Journal of Marketing*, *67*(3), pp.80-95.

Seppänen, R., Blomqvist, K. and Sundqvist, S., 2007. Measuring inter-organizational trust—a critical review of the empirical research in 1990–2003. *Industrial Marketing Management*, *36*(2), pp.249-265.

Sinkula, J.M., Baker, W.E. and Noordewier, T., 1997. A framework for market-based organizational learning: Linking values, knowledge, and behavior. *Journal of the academy of Marketing Science*, *25*(4), p.305.

Smith, P.G. and Reinertsen, D.G., 1998. *Developing products in half the time: new rules, new tools*. New York: Van Nostrand Reinhold.

Stevens, E., 2014. Fuzzy front-end learning strategies: Exploration of a high-tech company. *Technovation*, *34*(8), pp.431-440.

Strauss, A. and Corbin, J., 1998. Basics of qualitative research techniques. Thousand Oaks, CA: Sage publications.

Teece, D.J., Pisano, G. and Shuen, A., 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), pp.509-533.

Tóth, Z., Peters, L.D., Pressey, A. and Johnston, W.J., 2018. Tension in a value co-creation context: A network case study. *Industrial Marketing Management*, *70*, pp.34-45.

Tzokas, N., Hultink, E.J. and Hart, S., 2004. Navigating the new product development process. *Industrial Marketing Management*, *33*(7), pp.619-626.

Utterback, J., 1994. *Mastering the dynamics of innovation.* Cambridge, MA: Harvard Business School Press.

Vaast, E. and Walsham, G., 2009. Trans-situated learning: supporting a network of practice with an information infrastructure. *Information Systems Research*, *20*(4), pp.547-564.

Valtakoski, A., 2017. Explaining servitization failure and deservitization: A knowledge-based perspective. *Industrial Marketing Management*, *60*, pp.138-150.

Veldhuizen, E., Hultink, E.J. and Griffin, A., 2006. Modelling market information processing in new product development: An empirical analysis. *Journal of Engineering and Technology Management*, *23*(4), pp.353-373.

Welch, C., Piekkari, R., Plakoyiannaki, E. and Paavilainen-Mäntymäki, E., 2011. Theorising from case studies: Towards a pluralist future for international business research. *Journal of International Business Studies, 42(5),* pp.740-762.

Wenger, E., 2000. Communities of practice and social learning systems. *Organization 7(2),* pp. 225–246.

Wenger, E., 2010. Communities of practice and social learning systems: the career of a concept. In *Social learning systems and communities of practice* (pp. 179-198). Springer, London.

Wenger, E., McDermott, R.A. and Snyder, W., 2002. *Cultivating communities of practice: A guide to managing knowledge*. Harvard Business Press.

West, J. and Bogers, M., 2014. Leveraging external sources of innovation: a review of research on open innovation. *Journal of Product Innovation Management, 31(4),* pp.814-831.

Wuyts, S., and Van den Bulte, C., 2012. Network governance. In G. L. Lilien & R. Grewal (Eds.), *Handbook of business-to-business marketing* (pp. 73-89). Cheltenham, UK: Edward Elgar Publishing, Inc.

Yin, R.K., 2003 (3rd ed). *Case Study Research: design and methods*. Thousand Oaks.

Zahay, D., Hajli, N. and Sihi, D., 2018. Managerial perspectives on crowdsourcing in the new product development process. *Industrial Marketing Management, 71*, pp.41-53.

Zollo, M. and Winter, S.G., 2002. Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, *13*(3), pp.339-351.

Table 1: Theoretical approaches to inter-firm learning at the dyadic and network levels of analysis.

	Knowledge-Based Perspective to Learning	Practiced-Based Perspective to Learning	Relational-Governance Perspective to Learning
Dyadic Level of Analysis	▪ Three steps: (1) Asking the right question at the right time; (2) Absorbing the answers; (3) acting decisively *(Cyert and March, 1963*) ▪ Exploitative and explorative learning activities *(March, 1991; Kim and Atuahene-Gima, 2010)* ▪ Absorptive capacity: (1) to recognise; (2) to assimilate; and (3) to apply *(Cohen and Levinthal, 1990).* ▪ SECI process: (1) Socialisation; (2) Externalisation; (3) Combination; and (4) Internalisation *(Nonaka, 1994).* ▪ Three processes: (1) assimilation; (2) transformation; (3) dissemination. Emphasising knowledge transfer and transformation *(Hedlund, 1994*). ▪ Grafting new knowledge: (1) Creating; (2) Gathering; and (3) Cross-fertilising *(Inkpen, 1996*). ▪ Dynamic capabilities: (1) Integrating; (2) Building (3) Reconfiguring (*Teece et al., 1997*). ▪ Inter-firm learning types: (1) collaboration; (2) competition; (3) compromise; (4) accommodation; (5) avoidance (*Larsson et al., 1998*). ▪ Co-evolved dynamic capabilities: (1)	▪ Situated learning: learning is situated in work practices and is generated in the contexts of practical engagement (*Brown and Duguid, 1991/2001; Wenger et al., 2002; Lervik et al., 2010).* ▪ An act of participation by (1) collectively developing understanding (2) mutual engagement and (3) shared repertoire of communal resources *(Wenger et al., 2002; Roberts, 2006; Hotho et al., 2014).* ▪ The success of organisations depends on their ability to design themselves as social learning systems and to participate in broader learning systems such as industry, a region, or a consortium *(Wenger 2000).* ▪ Communities of practice help foster an environment in which knowledge can be created and shared and, most importantly, used to improve effectiveness, efficiency and innovation *(Lesser and Everest, 2001*). ▪ Four co-existing practice-based studies streams: (1) cultural and aesthetic	▪ Uncertainty and tension are key issues in inter-firm cooperation (*Hoholm and Olsen, 2012; Håkansson and Snehota, 1995)* ▪ Relational contracts are resistant to opportunism *(Carson et al., 2006; Argyres and Mayer, 2007)* ▪ Trust as basis in inter-firm relationships *(Selnes and Sallis, 2003; Seppänen et al., 2007).* ▪ Participation fosters process-based trust that results in inter-firm commitment (Brown and Duguid, 2001; Tóth et al., 2018). ▪ Trust facilitates knowledge transfer (*Seppänen et al., 2007; Bolmqvist et al., 2005; Bohnet and Baytelman, 2007*). ▪ The formality of contracts is a way of articulating, facilitating and simplifying the complexity of business interactions *(Mouzas and Ford, 2012)*

	experience accumulation (2) knowledge articulation; (3) knowledge codification *(Zollo and Winter, 2002*). ▪ Three-step model: (1) transfer; (2) transformation; (3) harvesting. Emphasising dialogue; knowledge integration; externalisation; shared meaning *(Beamish and Berdrow, 2003*).	approach; (2) activity theory; (3) situated learning theory; (4) actor network theory *(La Rocca et al., 2017).* ▪ Collective situated practices: learning by doing, learning by using, learning by interacting *(Bångens and Araujo, 2002; Popova-Nowak and Cseh, 2015).*	▪ Trust is developed over time and must precede any deeper learning *(Håkansson et al., 1999).*
Network Level of Analysis	▪ Knowledge networks increase learning *(Phelps et al., 2012; Carnabuci and Operti, 2013; Håkansson et al., 1999).* ▪ Innovation networks facilitate cross-fertilisation effects of different technologies *(Pyka, 2002; Akgün et al., 2006).*	▪ A need to consider network structure beyond organisational boundaries, requiring more research attention *(Pattinson et al., 2016; Hotho et al., 2014; Roberts, 2006)*	▪ Further research needed on tension and conflict in inter-firm networks *(Tóth et al., 2018; Hoholm and Olsen, 2012)* ▪ Limited systematic research on formal network governance *(i.e. Provan, Fish and Sydow, 2007; Mouzas and Ford, 2009; Wuyts and Van den Bulte, 2012)*

Table 2: Illustrative Data Analysis Evidence

(The number of interviewees whose statements affirm/imply the coded corresponding concept at three stages of NPD process.)

Total interviews: 39

Aggregate theme	Idea Management	Product Develop-ment	Product Launch	Total Count	Case Evidence Samples
Syndicated mode of learning: a cooperative spectrum	22 (73%)	6 (20%)	2 (7%)	30	"I was approached by Kate (a pseudonym) at a meeting, saying they have an idea of new on-line voucher system, and started asking us currently what we were doing, how we managed voucher, how we distributed them, how we recorded, how much vouchers sold, etc…And she asked if she could come and had some discussions with our people. So she met with finance department, marketing department, retail sales. From that, she got whole lot of information of what we previously did, then, she created a proposal of how their product could improve our voucher management. I guess it's because Kate. She is from this industry. She knows how to grab the real issues quick! " **(Customer, Case Toursim)** "…We listen to our customers. Customers are fantastic leveller for new ideas, especially customers' complaints. We learn so much from customers' complaints. When our new product solves their (customer's) problem, it is a guarantee of quick cash flow! Oh, yes, we did a lot of problem solving projects" **(Focal e-Commerce).** "……When I brought back some new thoughts I learnt from different seminars (as the idea pool) to my team, we were all very excited. We saw a very potential opportunity for our long term plan to compete with our competitors. From here, we started talking to our customers, working with our suppliers… This is how this cutting-edge product idea came from…" **(Focal, Case Energy**). 'This innovative idea was the very first one in the market, nobody had ever thought about it until we brought it up…We are very proud…' **(Focal, Case Energy).**

Situated mode of learning: a co-Participation approach	5 (15%)	24 (73%)	4 (12%)	33	"The language they (Focal's supplier) used was different from the language we used, although we all spoke English. It was very difficult to communicate with them. They found difficult to understand us, and we found difficult to understand them. This understanding issue could be a big mass!" **(Customer's customer, Case e-Commence).** 'My goodness, it was very difficult for us to understand their process. It involved customer relationships, accounting and finance, even legal department…In the beginning, it was a chaos….' **(Supplier, Case Tourism).** "We asked them to provide us some blueprints and documents to study. We had key personnel to work together. We arranged conference calls and several discussions and present our understanding to our client to check if that was what they want, we trial and error…After two months, an intellectual 'Aha!' clicked…" **(Customer's customer, Case e-Commerce).**
	15 (41%)	13 (35%)	9 (24%)	37	'No protection agreement, no talk!' **Focal, Case e-Commerce).** "…there was a company asking us for solutions. But they were not willing to sign a confidentiality agreement, which meant we gave them the solution, they could take it and go somewhere else to sell it. So, I just say 'SORRY! We cannot afford that!' We never approach them again since then…Without protection, we just cannot work with any partners at any stage! This is important." **(Supplier's customer, Case Energy).**
Synergised Mode of learning: a co-evolution configuration	9 (36%)	3 (12%)	13 (52%)	25	'Product launch is a complex task for us! We had a client from Saudi (Arabia) asking to install this product in order to explore new field (for oil). The installation required us to learn from their (the Saudi client's) local supplier in order to make sure the technological computability. Then we had to work with their joint venture to make sure there was no legal issue. This took us about one year to make sure everything was in place. But we are happy to have this experience. Now, we have a successful case that we are much better to sell our product in the international market…' **(Focal, Case Energy).** "Now when we look back, we actually learn more from launching our product.

					Each of our customers is different, their needs are different. We learn different things from them (customers). Our customers would tell us where we can do better next time. Now, when our other customers need any special functions for their business, I understand better and always provide the best solution for them. It is the learning from so many parties helped me. Without working in the networks, our business is simply non-existed!" **(Focal, Case Tourism).**

Table 3: The 4S Modes

Mode	Goal	Activities	Results	Applied at the NPD Stage	Relevant Literature
Syndicated	For a coordinative spectrum	Network actors combine and balance learning approaches (e.g. exploitative and explorative learning) through a syndicate manner that crosses project, time and firm boundaries.	• This mode helps network actors to achieve a more balanced strategy for short-term profit and long-term survival. • This mode facilitates the open-ended learning loop.	• Idea generation (73%) • Product development (20%) • Product launch (7%)	Hagedoorn & Duysters ,2002 Schweitzer et al., 2018; De Brentani & Reid, 2012; Kim & Atuahene-Gima, 2010; March, 1991; Möller & Halinen, 2017; Brown & Duguid, 2001
Situated	For co-participation	Network actors engage in physical and virtual co-participation with direct and indirect network actors.	• These activities help to improve understanding and communication. • These activities help to reduce learning obstacles.	• Idea generation (15%) • Product development (73%) • Product launch (12%)	Cook & Brown, 1999; Nonaka, 1994; Lave & Wenger, 1991/2000; Brown & Duguid, 1991; Lervik et al., 2010; Blackler 1995; Felin et al., 2012; Pentland & Feldman 2005
Selected	For secure attachment	Network actors privilege learning actors with formal contractual governance.	• This activity helps to reduce tensions caused by uncertainty and distrust.	• Idea generation (41%) • Product development (35%) • Product launch (24%)	Schoorman et a., 2007; Knudsen, 2007; Felin, 2012; Alexy et al., 2009; Owen-Smith & Powell, 2001; Dayan & Di Benedetto, 2010; Land et al., 2012; Mouzas & Ford, 2012
Synergised	For co-evolution	Network actors co-evolve through a synergised manner to cross-pollinate for greater value than the sum of dyadic value co-creation.	• This activity enables network actors to generate greater learning value than the sum of dyadic value co-creation. • This activity functions as a conduit for operating an open-ended learning loop.	• Idea generation (36%) • Product development (12%) • Product launch (52%)	Laursen, 2012; Akgün et al., 2006; Pyka, 2002;

Figure 1: Conceptual Framework

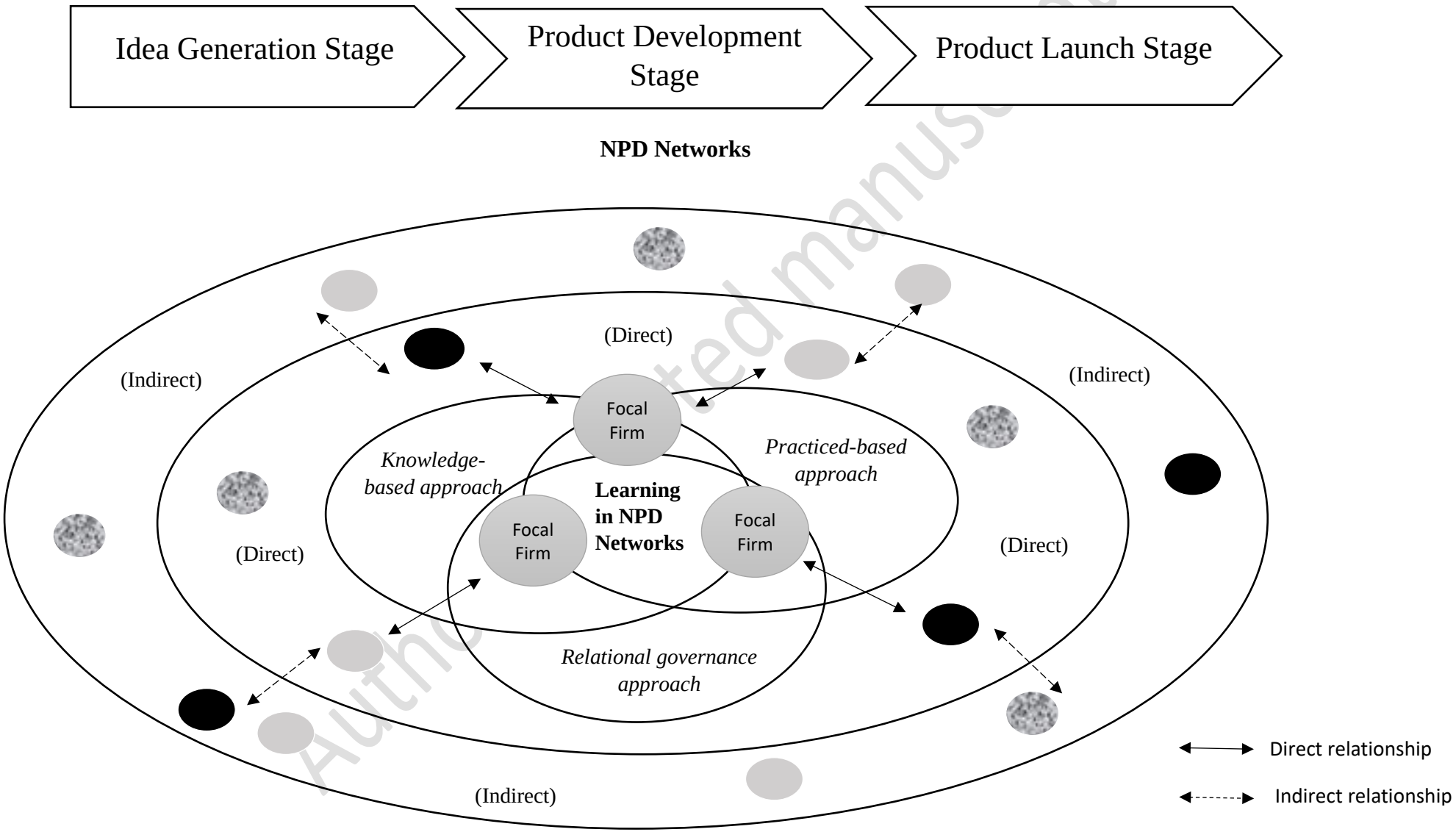

Figure 2: The 4S Model of Inter-firm Learning in NPD Networks