Title

A Learning Process for NPD in Business Networks

1. Introduction

"In a recent Accenture survey, 89% of executives agreed that innovation is as important as cost management for high performance. But while many companies are investing more in innovation, only a few have a rigorous approach for managing the process…"
(Financial Times, 31 March 2010, p.3)

In recent years, the growing complexity of products and increasing competition in markets has led firms to collaborate with external organisations. For the success of new product development (NPD), practitioners have devoted much interest to building relationships with other firms that many contribute mutual benefits. Scholars too have highlighted the important of 'inter-firm collaboration', 'innovation networks' (e.g. Powell et al. 2005; Pyka 2002; Gnyawali & Madhavan 2001). Much evidence exists to suggest that new product development (NPD) is an outcome of inter-firm learning in business networks (Badir and O'Connor, 2015; Baker et al, 2016; Liu 2015; Roberts and Candi, 2014; Powell et al. 1996; Johnston & Paladino 2007). If inter-firm learning in business networks plays an essential role for new product success, it is critical to know how this learning in business networks is taken place.

Research on network learning process includes the work of Beamish and Berdraw (2003) and Nonaka and Toyama (2005), who identify respectively the models of transfer – transformation-harvesting and the SECI process – socialisation, externalisation, combination, and internalisation. Other ideas of importance to emerge in the field of learning include

'protectiveness', (Hamel 1991, McEvily et al. 2004; Saunders et al. 2014), whilst the terms exploitation and exploration of learning (March 1991), explain how firms learn either from the refinement and extension of existing competences or from the experimentation with new alternatives. Yet these studies and others in their wake have not been focused on product development management per se and their insights remain unsynthesised in this context such that we still do not know 'how does learning happen in product development networks?' In order to find out the answer, we commenced a cross-industry multiple-case study to explore the empirical practices.

The organising framework for this research is addressed through examination of learning in three broad stages of the NPD process, namely, the idea generation, product development and launch cycles. In order to meet the challenge of finding appropriate samples in network research (Andersson and Dahlqvist 2001; Håkansson and Johanson 2001), a 'snow-balling' approach was adopted, with the unit of analysis being a completed product development project within a network. In total, three case studies were compiled by 39 in-depth interviews and direct observations in 11 product development business forums, together with archival records and documents.

This article contributes to the knowledge in three aspects. First, the study contributes a '4S' network learning model to the literature, portraying empirical practice in NPD networks. The model synergized modes syntheses key learning approaches along the entire NPD process. Second, the study, with evidence, challenges the existing literature, arguing that firms do not necessarily 'trade-off' (as the literature suggests), rather they syndicate, exploitation and exploration. The study also questions whether the existing NPD process (i.e. idea, development and launch) is appropriate in study NPD network learning. This leads to an important area for

further research. Finally, it offers practical guidance for mangers seeking to learn in a context of NPD network collaboration.

This article is structured as follows: Section two provides an overview of theoretical background. Section three explains the research method. Section four presents case study's findings and discusses implications to theory and practice. This article concludes by the limitations of the study and the suggestions for further research in Section five.

2. Theoretical Background

In the extant literature, the notion that the development of new products involves a sequence of stages and gates is long-established (Cooper 1988, Powell, et al. 1996; Song et al., 2007; Markham, 2013; Eling et al., 2013). Prior research suggests that for the success of product development, firms seeks knowledge resources to mitigate uncertainties embedded at each stage (Moenaert and Souder, 1990; Reid and Brentani, 2004; Cooper, Edgett and Kleinschmidt, 2004). Theories of 'collaborative learning', 'innovation networks' and 'communication integration' have drawn much research interest in this context (e.g., Rogers, 1962; Håkansson et al., 1999; Gnyawali and Madhavan, 2001; Pyka 2002; Powell et al., 2005; Baker et al., 2016), founded on the view that business networks provide access for solutions and resources, increasing the likelihood that new knowledge and information can be effectively integrated, enabling firms to draw novel association that encourage new ideas and innovations (Dyer and Singh, 1998; Beamish and Berdraw, 2003; Håkansson and Ford, 2002; Nonaka and Toyama, 2005; Liu and Hart, 2011). Whist previous research contributes to our understanding about inter-firm relationships and learning in NPD networks, most relevant studies either are fixed at

one particular stage - fuzzy front end or are rather generalized: a synthesized, stage-wise understanding of learning is largely neglected in the extant literature.

In the NPD literature, the fuzzy front end has drawn much research attention. The fuzzy front end is considered to be the earliest stage of the NPD process (Smith and Reinertsen, 1991), focusing on innovative ideas prior to the development stage (Cohen and Levinthal, 1990). To generate commercially successful ides, research has suggested that firms should acquire and assimilate information and knowledge from external source (Kim and Wilemon, 2002; Chen et al., 2011; Stevens, 2014). The fuzzy front end involves various activities from searching and identifying problem and opportunity (Liefer et al., 2000; Urban and Hauser, 1993); information collection/exploration (March, 1991); to 'up-front homework' (Cooper, 1996). It also concerns the aspects of idea generation and concept development (Cooper, 1990; Urban and Hauser, 1993; Montoya-Weiss and O'Driscoll, 2000; Kijkuit and van den Ende, 2007); continued information collection, and pre-screening (Crawford, 1980; Crawford and Di Benedetto, 2003). Prior work all points to the crucial role of generating good new product ideas at this stage.

Some scholars have noted that 'intuition' may play an important role in generating new ideas (e.g. Dayan and Di Bendetto, 2011; Armstrong and Hird, 2009). Others, on the other hand, hold that innovative ideas does not happen by chance (e.g. Akinci and Sadler-Smith, 2012; Dane and Pratt, 2007). Eling et al., (2014) who study using intuition in fuzzy front-end and suggest that intuition may be beneficial in some situations but harmful in others. From an information processing view, de Brentani and Reid (2012) highlight the importance of the acquisition of information and knowledge for both incremental and discontinued new products at the fuzzy front end. They found that incremental new products which often involve structured problems or opportunities, are typically initiated at the organizational level with an

information flow from within. In contrast, for discontinuous new products, which are developed in less structured ways, new ideas are often generated when firms working with outside partners (e.g. customers). As such, new information from external linkages has been viewed as vital for developing new ideas (Wind and Mahajan, 1997; Alam, 2003).

In the extant literature, the fuzzy front end involves processes of information gathering and adoption from the external networks is well recognized (e.g. Reid and de Brentani, 2004; Roos, Crossan et al., 1999; Roos, 1996; Macdonald and Williams, 1994). For example, Quinn (1985) has highlighted that technology tends to advance through a series of insights frequently triggered by interactions between the discoverer and the outside world. Utterback (1994) has also noticed that new products, especially new-to-the world products, tend to be initiated from outside the current industry players. However, the extent to which good new and innovative ideas are generated through learning from these 'external' business networks and the impact of this learning on the unfolding of the later stages of the NPD process are issues that remain to be understood. Moreover, the impact of the network learning in the fuzzy front end on learning throughout the rest of the development process also remains poorly understood, even though the processes, which is one of continuous uncertainty reduction requiring learning across the various stages. Literature on inter-firm learning literature more generally, provides some conceptual guideposts which might be used to build more understanding of inter-firm learning throughout the NPD process and is the subject of the next section.

In the inter-firm learning literature, the transfer of tacit knowledge has been viewed as a core challenge (Polanyi, 1966; Nonaka and Tackeuchi, 1995), echoing the widely held view that the development of new product is a complex process that often involves tacit knowledge which is difficult to express and encode (Cook and Brown, 1999; Mascitelli, 2000; Goffin and Koners,

2011). This issue has led much research interest, resulting in several salient theories. For example the theory of SECI process (Nonaka, 1994) highlights the interaction between tacit and explicit knowledge. SECI model is concerned with an inter-firm learning process involving socialisation, externalisation, combination and internalisation. It highlights dynamic learning as a dialectical process (Isaace, 1993). Dialogue, which facilitates a process for transforming quality conversations, has been central to inter-firm learning in business networks, as a means of tackling the issue of tacitness (Issacs, 1993; Grant, 1996; Hazen, 1994; Beamish and Berdrow, 2003).

A further theoretical lens used to study the issue of tacit knowledge is 'situated learning theory' (Lant, 1999; Sarma et al., 2001; Sherwood and Covin, 2008). Situated learning theory holds that the learning context is central to the successful acquisition of knowledge and skills from others (Brown et al., 1989). Scholars of situated learning theory contend that the social and physical context in which learning takes place is vital because knowledge is embedded in the use and practice of knowledge (Brown et al., 1989; Lave and Wenger, 1991). In this sense, factors such as experience-related aspects (e.g. learning by doing) and partner interface mechanisms (e.g. communications) are viewed as necessary elements for knowledge acquisition and inter-firm collaboration (Cohen et al., 2002; Das and Teng, 1998; Dyer and Singh, 1998). Mascitelli (2000), who highlights learning by doing and experimentation, further depicts the link between tacit knowledge and situated learning.

In studying learning, there are two distinct approaches of how learning might take place. One learning approach is the marginal refinement of existing practices as experience accrues. Another approach yields more radical, and innovative improvements, as for example, explained by March' (1991) in his work on the topic of exploration and exploitation in organisational

learning depicted the details. March (1991) termed the experiential learning as exploitation and innovative learning as exploration:

'Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution' (p.71).

In other words, the essence of exploitation emphasises refinement and extension of existing competences, and technologies, and exploitative learning's returns are positive, proximate, and predictable. The essence of exploration, on the other hand, is experimentation with new alternatives, and its returns are uncertain, distant, and sometimes negative (Leonard-Barton 1992; Kyriakopoulos and Moorman 1998, 2002). In this regard, previous research has argued that both exploration and exploitation are essential for organisations, but they compete for scarce resources; consequently,there is an 'either/or' trade-off choice an organisation has to make between exploration and exploitation (see form example, Kyiakopoulos and Moorman 1998, 2002; Dickson 1992; Leonard-Barton 1992).

Prior studies have pointed to that inter-firm networks enable the exchange of knowledge between networked partners that stimulate learning, but also suggests the very same mechanism that brings a firm into contact with novel knowledge and proves to strengthen competitive advantage may also damage it (e.g. Vanhaverbeke et al., 2012; Nooteboom, 2004). For example, capability building theory stresses interfirm learning in business networks provides firms with access to new knowledge, enabling them to combine complementary capabilities, to enhance the creation of new products (Teece et al., 1997; Slater et al., 2014). Governance theory and agency theory, other the other hand, consider the unintended consequences whereby

resources are appropriated or nt shared among the parties involved. (Dosi and Marengo, 2000; Williamson, 1999, Eisenhardt, 1989; Hoenen and Kostova, 2015). Thus, appropriation has been viewed as an issue that needs to carefully manage in inter-firm learning.

A final strand of research in inter-firm learning has emerged in the notion of the 'competency trap'. This idea highlights the risk run by firms that are rigidly dependent on prior experience and existing knowledge of creating inflexibility (Leonard-Barton, 1992; Winter 2003). Of particular relevance to NPD, being overly committed to prior learning may hinder successful NPD (Wang et al., 2015), requiring that firms also develop an ability to 'unlearn' in order to be ready to learn afresh and avoid the trap of prior knowledge (Akgun et al., 2006).

Despite many issues embedded in network learning (as discussed above), previous studies have shown a significant contribution of network learning to NPD (e.g. Baker et al., 2016; Powell et al., 1996). For example, the concept of 'collective invention' through an 'industrial network' approach for new product success has been noted (Allen 1983; Hellstrom & Malmquist 2000). Companies are increasingly seeing alliances with other firms in markets as a way to develop successful new products (Biemans 1992; Powell et al. 1996; von Hipple 2001) and rely on collaborative relationships in the tightly networked business markets to access, survey and exploit emerging market and technological knowledge (Hakansson et al. 2002; Ford et al. 2002; Rindfleisch & Moorman 2001). Although they have disparate approaches and foci, the disciplines of business networks and NPD are often interrelated and contribute to the overall effort for a firm's competitive advantages and its long term survival.

In conclude, new product success relies on collaboration in business networks. Inter-firm learning in an NPD network context is more multifaceted compared to interaction taking place in a dyadic relationship. Collaboration in NPD networks facilitates access to complementary

resources and improves firm's competitiveness (Hellstrom & Malmquist 2000; Rindfleisch & Moorman 2001; Johnston & Paladino 2007), thereby providing product developers with the conduits for new information transfer and knowledge co-creation for improved NPD (Powell et al. 1996; Mohannak 2007). Whilst research all points to that learning in NPD networks is not optional but a compulsory action, we know little about how such learning occurs in NPD process. To address this under-researched topic, we conducted a multiple-case study to explore the empirical practices.

3. Research Method

3.1 Research Design

To understand how learning occurs in product development networks, we conducted a cross-industry multiple-case study to explore the empirical practices. The organising framework for this research is addressed through examination of learning in three broad stages of the NPD process. We adopted the work by Cooper et al., (1991) and Markham (2013) to identify three major stages the NPD process: (1) idea management (included idea exploration, idea screening and business analysis); (2) product development (covered the stages of development and testing); and (3) commercialisation (focused on product lunch). In order to meet the challenge of finding appropriate samples in network research (Andersson and Dahlqvist, 2001; Håkansson and Johanson, 2001), a 'snow-balling' technique was adopted, with the unit of analysis being a completed product development project – a case study - within a network. The case studies were drawn from a hub-and-spoke approach, where 'hub' companies were those that initiated and worked with networked 'spoke' partners for the NPD projects.

The case studies were advanced through three major phases. Phase one mainly involved the selection of three quality 'hub' companies through various business networked forums and events. Phase two investigated the hub company and their spokes by direct ties (e.g. customers or suppliers). Phase three then extended the study into the spoke companies through indirect ties (e.g. a customer's customer). Figure 1 illustrates this three-phase approach. During the first phase, direct observations were used and notes were taken to identify potential hub companies. Hub companies were selected based on three criteria. First, companies were with a successful NPD project in the past three years. Second, companies involved in the NPD project via business networks. Third, companies were willing to provide the name list of their networked partners in the studied NPD project. As a result, three hub companies were selected from three different industries: e-Commerce, energy and tourism. Three hub companies were all from the UK.

<Insert Figure 1 near here>

3.2 Data Collection and Analysis

In collecting data, semi-structured interviews together with observation, documents and archived records were employed. Two protocols were developed for each hub – the case protocol and the semi-structured interview protocol to improve reliability by providing a degree of systemisation in the procedures and questions over the multiple cases (Yin, 2003). All the interviewees were first 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); they were then asked to describe how the company manage inter-firm learning with important network partners (with whom they ranked >= 3) in the NPD project. Interviews lasted approximately

30 minutes to 95 minutes (see Table 1). To ensure construct validity, multiple sources of evidence were used (Eisenhardt, 1989). All the interviews were tape-recorded, note-taken, transcribed. Transcriptions were sent to interviewees to review, followed by revisions if any. Documentary information related to the studied NPD project was collected, which included: letters, memoranda, agendas, announcements, the minutes of meetings, new clippings and other written reports. Archival records were collected, such as service records, organisational records, and company collateral.

In managing and analysing data, NVivo 7 and tabulation were used. The tactics of 'clustering' and 'comparison/contrast' were employed for data display and reduction (Miles & Huberman 1994). In analysing data, this study used the process of within-case data analysis and cross-case patterns searching to shape propositions (Eisenhardt 1989). The technique of comparisons/contrasts is a classic way to test a conclusion. To ensure internal validity, the study employed pattern match to process research data (Yin 2003). Data were processed, reduced and organised constantly until themes appeared and cross-case patterns emerged. For the external validity, the study used the multiple-case design and the replication logic to capture the commonalities across the cases (Yin 2003). The study adopts the techniques of 'counting' and 'comparisons/contrasts' (Guba and Lincoln 1981) and Miles and Humberman 1994) to assist the analysis process. The technique of counting accommodates the selection of themes when (a) themes (or patterns) happen a number of times and (b) they consistently happen in a specific way (Miles and Humberman 1994). The study further tied the emergent theory to the extant literature (when appropriate) to enhance the internal and external validity as suggested by Eisenhardt (1989). A counted table of emergent themes with the respective case evidence samples is provided in Appendix 1.

3.3 Three Selected Cases

Hub e-Commerce was established in 1996 as an independent supplier of internet product and services for business customers. The company had successfully developed a patented product and was well used in the industry. The unit of analysis (i.e. the focal NPD project) was a new developed product to provide advanced search engine service. This new product was launched in solving long lasting customer complaints. Case e-Commerce was established by the hub company with its eight direct-tie networked companies and four indirect-tie networked companies (See Table 1).

Hub Energy was a mechanical engineering company specialised in engineering services and production equipment for both operators and service companies in the oil and gas industry. With its funders' long working experience in the industry, Hub Energy successfully invented and launched a new product to tackle a problem that had been an unsolved problem for a long time. Case energy was established by the hub energy with its nine direct-tie networked companies and three indirect-tie networked companies (see Table 1).

Hub Tourism was founded by two entrepreneurs with an innovative idea. The idea then was turned into a successful product that was used (and purchased) by many well-known and desirable hotels to create a range of very sought-after gift voucher experiences. The product was the first of its kind in the UK. Case Tourism was established by the hub company with its eight direct-tie networked companies and four indirect-tie networked companies (see Table 1).

Table 1 summarises the demographics of the hub and their network companies, the informants' background, and the length of interview for each case. Subject to the confidentiality agreement between the companies and the researcher, company identities are concealed.

<Insert Table 1 near here>

4. Findings and Discussion

In this study, we are concerned with how learning takes place beyond firms' boundaries. We first investigated what facilitated learning along the NPD process stages in three case studies. We then developed a synthesized model to depict how learning takes place in business network for NPD.

4.1 A Syndicated Mode for Ideas

Along with many studies, our data suggest that to generate commercially successful new product ideas is the key at the early fuzzy NPD stage. (Cooper, 1990; Stevens, 2014). To achieve this objective, our data further suggest that firms undertake a practice that combines previous learned and newly gained knowledge in order to engender a new product idea. This involves exploiting previous learning in NPD networks together with exploring advanced knowledge learned from existing business networks. In our case studies, this integration of exploitation and exploration of prior and new learning has been repeatedly stressed in our case studies. For example: *"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).

In the learning literature, there are two distinct approaches to how learning takes place (March, 1991; Kyiakopoulos and Moorman 1998, 2002 exploitation and exploration. The experience described by our case studies, however, is somewhat different from the prior research that stresses a 'trade-off' between exploitation and exploration. Rather, there seems to exist a joint effect by combining exploitation learning from prior NPD projects and exploration learning from current NPD projects for a commercially viable new product idea. Both exploitive and explorative approaches to learning are 'syndicated' with each other. A central concern of adaptive processes studies (Levinthal and March, 1981) in firm's learning is the relation between of explorative learning and exploitive learning. That is, the problem of balancing exploration and exploitation is exhibited in distinctions made between refinement of existing knowledge and invention of new knowledge. Our data reveal how network actors seek a balance from the practical needs of firms. As one of our interviewees emphasised *'…Oh, we need to do both at the same time. On one hand, we solve our customers' problem 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 only company that can solve customers' existing problem. It is these new ideas that beyond customers' expectation, keep us very competitive in this market'* (Supplier, Case Energy)

Our data indicate that to generate new product ideas there exists both a reactive and a proactive learning engagement. As highlighted by one of the suppliers in the Case-Energy (see above), one engagement involves in a reactive problem-solution in markets New product ideas/concepts are generated by learning from network partner's problems, such as learning from customers' problems o. In this way, a firm, playing as a solutions provider, learns about what the problems and customers' needs are. A new product idea is thus conceived from this 'reactive' market learning engagement. As another interviewee stressed: *"…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*!" (Hub e-Commerce). Indeed, a new product idea driven from a customers' problem solving approach is much easier to be accepted by the market and hence guarantees a 'quick cash flow'.

Another approach was found in parallel for companies to manage network learning for new product ideas – a proactive new product idea initiation. This happened in the cases that an NPD opportunity was identified from firm's learning in its business networks. This exercise was well described by one of our hub companies: *"……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 new product idea came from…*" (Hub, Case Energy). Companies collect market information and exchange technological knowledge and know-how in an 'ideas pool' facilitated by collaborative networks. A new product idea was initiated by learning from this 'idea pool'. . The results of case studies suggest that the proactive initiation approach is likely to promote the opportunity for new-to-market NPD for that the generated new product ideas often go

beyond the existing market constraints. As our hub company in case Energy further highlighted *'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…'* (Hub, Case Energy). Despite its longer lead time for customer buy-in due to its newness, the proactive initiative approach indeed holds the potential of long term competitive advantages for firms growth.

So far, the case studies results indicate that at the idea generation stage, firms engage in a combined a reactive approach through exploiting learning from network partners (e.g. customers) and a proactive approach through exploring new ideas. Whilst some researchers (e.g. Dayan and Di Bendetto, 2011) suggest that new idea comes from intuition, our study suggests that innovative ideas do not happen by chance as claimed by others (e.g. Akinci and Sadler-Smith, 2012). Rather, an *'idea pool'* which is derived from all sorts of external sources, plays an essential role in this process, as highlighted by our Hub Company in the Case-Energy). In maximize the benefit of two learning endeavours, network partners seek combined effects of exploitation and exploration. To balance the efforts for short and long term survival, learning actors jointly apply a reactive problem-solution approach (to bring in quick cash for a firm's survival) and a proactive new product idea initiation approach (to enhance a firm's long term growth). This study terms these exercises as the **'syndicated mode'** to depict that learning actors join two opponent learning approaches (i.e. exploitation and exploration, reactive and proactive) together in a syndicate. While our case study suggests that firms engage in the syndicated learning mode for new product idea, its application is not limited at the NPD idea generation stage, which we will discuss further in the following section.

4.2 A Situated Mode for Understanding

As our attention moved to the product development stage, a repeating theme emerged: 'understanding each other'. As highlighted by our interviewee in one of our case studies "*The language they (Hub'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 mess!*" (Customer's customer, Case e-Commence). Another case found similar problem: '*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).

In the literature, the issue of understanding appears to be related to knowledge tacitness. As mentioned earlier, 'tacitness' of knowledge is one of the most widely recognised barriers to its transfer and replication when dealing with inter-firm learning (Polani 1966; von Hippel and Katz 2002; Nonaka and Toyama 2005). Our data echoes this strand of work, suggesting that understanding tacit knowledge often reveals itself as problematic at the product development stage where the transfer of complex knowledge such as technological know-how is challenging. That is, firms face difficulties in turning tacit know-how into explicit, because they simply do not understand each other. One of our samples vividly depicts: '*…We both spoke English, but 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, e-Commerce). Indeed, in this case, an 'interpreter' is needed to turn tacit knowledge (know-how in finance discipline) into explicit.

When asked how the understanding issue was dealt with, the conversation with the supplier in e-Commerce case continued: "*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).   Our case study suggests that an interpreter to turn tacit knowledge into explicit is 'situated learning' by working together.

As discussed earlier, 'situated learning theory' highlights that the social and physical context is vital for learning. Our study with empirical evidence supports this theory, showing that a situated context is especially important when a better understanding is required to transfer tacit know-how at product development stage in particular.   That is, they work together, communicate via conference calls and face to face meeting, study each other's documents and take trial and error approach, as indicated in the above quote. Two decades ago, Grant (1996) has pointed out that firms' capability to turn tacit knowledge into explicit is the key to better business networks learning. Nonaka's (1994) SECI theory and Mascitelli's (2000) concepts of 'learning by doing' and 'trial and error' further enhance the belief of situated interaction in turning tacit knowledge into explicit. Along with this school of thought, this study terms this learning approach as the **'situated mode'** to depict that in order to turn tacit knowledge into explicit, learning actors 'work together' either physically or virtually to better 'understand' each other. Although we find the situated mode is largely used in the product development stage, we also find that firms use this mode at other NPD stages which will be discussed later.

4.3 A Selected Mode for Protection

'*No protection agreement, no talk! See…new product ideas is our lifeblood. If there this no protection, we will never ever work with any outsiders…*' (Hub, Case e-Commerce). A core

theme appears throughout all of our studied NPD cases – 'protection'. Whilst working together and understanding each other are important in NPD network learning, without protection (especially for intellectual property), our data suggest that many companies are simply unwilling to collaborate with network partners as the e-Commerce Hub stresses the condition: 'no protection agreement, no talk'. This conditional term is well described by one of our interviewees: *"...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). Data also suggest that this 'conditional' term is applied in the entire NPD process from the fuzzy front end to new product launch.

In the NPD literature, the issue of intellectual property (IP) protection has drawn much research attention (e.g. Vanderbyl and Kobelak 2007; Hanel 2006; Davis 2004; Gallini 2002). Previous studies however show different (sometimes conflicting) results. Some scholars have suggested that IP protection hinders the technology transfer and prevent more innovation (e.g. Alexy et al. 2009; Owen-Smith and Powell 2001). Others who look at the relationship between the stringency of IP protection and NPD performance found that having an effective protection of IPRs (intellectual property rights) promotes better in NPD performance (e.g. Park 2001; Kanwar and Evenson 2003; Hanel 2006). According to Gallini (2002), a stronger legal right to exclude others from using an invention generally provides a stronger economic incentive to include them through licensing or legal agreement. Although whether 'protection' hinders or promotes better NPD is not the topic in this study, our study with empirical evidence does support that learning actors select their learning partners based on whether a protection

condition is held. A protection condition grants a sense of secure to learning partners through formal (e.g. contract) or informal (e.g. oral agreement) procedure. This study terms this approach as '**selected mode'** to depict that learning actors learn with selective network partners to avoid issues such as opportunist or free-ride behaviour (Hoenen and Kostova, 2015; Dosi and Marengo, 2000).

4.4 A Synergised Mode for Greater Total Effect

When our study moved to a product launch stage, data indicate that network actors integrate knowledge and know-how learned from different NPD partners, resulting in a greater total effect. This result was solving a complex NPD problem where a company works with one networked partner to solve one part of problem and works with another for another part of problem. This phenomenon is described by our interviewee: '*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…*' (Hub, Case Energy). Noticeably, these learning relationships are mutual and expendable. As Hub-Energy told us later that the above 'local Saudi supplier' had transferred the learning from them and developed another new product idea. This supplier turned themselves as a hub-company in another NPD project.

This learning process is similar to cross pollination was well described in another case study: "*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!*" (Hub, Case Tourism). In this case, the hub-company learns from various network partners (customers, in particular) at the launch stage. The launched product was 'pollinated' with new suggestions and turn into an even better product waiting to serve next customer. This learning approach appears to be vital in NPD network learning yet remains under-researched. In this study, we use the term '**synergised mode**' to describe that learning actors integrate learning from different NPD network partners (from prior or current projects) to enjoy the benefits from collective advantageous knowledge conjunction. More importantly, because the application of synergized mode is mutual and expandable, the engagement facilitates participated actors to generate a total effect of learning to be greater than the sum of the individual learning effects. Figures 2 illustrates the synergised mode of network learning.

<Insert Figures 2 near here>

4.5 An NPD Network Learning Model in a Loop

As discussed earlier, in seeking a synthesized understanding of how network learning takes place we followed a stage-by-stage process suggested in the NPD literature (e.g. Cooper, 1985). Our data however reveal that this presumed stage process may not fully grasp a total

understanding of learning in NPD networks. Several important messages are emerged. First, data suggest that learning in NPD networks takes place as a loop and it is difficult to identify where the point of start and end is. As discussed earlier, data show that a new product idea generated at the idea management stage is tightly linked with network learning from the previous NPD projects (i.e. an exploitative learning). This finding leads us to assume that there exists a thread leading network actors' learning from one NPD project to another. Learning in NPD networks is formed and expanded in a threaded loop.

Furthermore, the proposed 4S modes (syndicated, situated, selected and synergized) seems rather prominent at its respective NPD stage, as discussed above. The actual application however is not that straightforward. For example, in some cases it was indicated that network actors also applied situated mode at idea management stage. As one of our interviewees reflected: '*In order to better understand their problem, they (Hub) joined our workshops and meetings, few months after, they came back with a better product idea…*' (Customer's customer, Case e-Commerce). Whilst the situated learning mode is important at the product development stage, we also find evidence that this mode is also applied at the idea generation stage. This leads us to propose that the application of an appropriate learning mode network should not be confined in its clear-cut compartment (e.g. NPD stage). Rather, a NPD network learning model comes in a loop with the right learning approach for the right activity at the right time. By proposing a 4S network learning model with its connoted context, we hope to shed some light to this complex issue. Figure 3 illustrates this 4S' network learning model in a loop. A summary of case study evidence is provided in Appendix 1.

<Insert Figure 3 here>

5. Conclusion

In the literature, scholars in studying fuzzy front end often stresses how 'fuzzy' it could be at the idea generation stage. Against the odds, our data seem to suggest it is not that 'fuzzy' when dealing with network learning process – reactive approach for quick revenue and proactive approach for long-term competitiveness. Researchers who adopt an interpretive approach emphasise situated learning process that helps create 'shared meanings' (Dougherty 1992) and mechanisms that reconcile discrepancies through dialogue (Nanaka & Takeuchi 1995). Learning for partners from different disciplines is indeed uneasy. The solution seems to lie in 'working together' through dialectical process (Isaacs, 1993), through socialisation process (Nonaka, 1994) and through situated learning (Sherwood and Covin, 2008).These theories coincide what our data have suggested that tacit knowledge needs to be turned into explicit. Our study further evidenced companies often engage in the situated mode by using tactics such as learning by doing together or trial and error, providing practical and actionable guidance in this context. Today, knowledge is the principal economic asset and its management and protection have become the cornerstones of corporate strategy. Our study further indicates that, protection (e.g. for IP) is always a concern, the selected mode is prevailed in the entire NPD process for companies to decide whom they would/would not like to work with. Does IP protection discourage inter-firm learning in NPD networks? Not necessarily. As Hall and Ham-Ziedonis (2001) have found that stronger IP protection may inspire strategic patenting for the purpose of cross-licensing and thereby they claim that IP protection may facilitate the exchange and diffusion of new knowledge. As one of our samples from case-energy highlighted: "*we work more closely and openly with our alliances who signed the confidentiality agreement with us*!" In the extant literature, the synergised mode is still an under-researched area. Marsh and Stock' (2006) theory of 'integrative practice' and Pyka's

(2002) 'cross-fertilisation effect' provides potential path for further research. Today, firm's business networks provide abundant learning opportunities and have been described as firm's resources in dealing with uncertainties in changeable business environment. However, firm's learning in network context remains complex and difficult for that different network actors may have different goals and strategies. We hope this 4S learning model provides some clue in better managing network learning in NPD process.

This study is not without limitations which lead to several areas for further research. First, case study is used to explore an under-researched topic. Although multiple case studies are used for better validity, large scale research (e.g. survey research) is recommended for better generalization. Second, we designed this research under three major NPD stages. While this design allowed us to explore empirical practices in an organized manner, it also limited our study into very broad new product developing processes. Therefore, for future research in this context, a more detailed stages should be considered for different NPD projects. Finally, this study sheds some light on this topic based on data collected from three important industries (e-Commerce, energy and tourism). A similar research conducted in different industries will deepen our understanding in this important topic.

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Appendix 1: A Counted Table of Emergent Themes with Case Evidence Samples

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

Total interviews: 39

Emergent Theme	Idea Genera-tion	Product Develop-ment	Product Launch	Total Counting	Case Evidence Samples
Syndicated Mode for Idea	22/39 (56%)	6/39 (15%)	2/39 (1%)	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!" **(Hub 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 new product idea came from…" **(Hub, 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…' **(Hub, Case Energy).**
Situated Mode for Under-standing	5/39 (13%)	24/39 (61%)	4/39 (10%)	33	"The language they (Hub'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-Commence).**
Selected Mode for Protection	15/39 (38%)	13/39 (33%)	9/39 (23%)	37	'No protection agreement, no talk!' **(Hub, Case e-Commence).** "…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 for Greater Total Effect	5/39 (13%)	2/39 (1%)	17/39 (44%)	24	'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…' **(Hub, 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!" **(Hub, Case Tourism).**

Table 1: The Profile of the Hub and their network companies

COMPANY	INDUSTRY	RELATION TO HUB	SIZE	INTERVIEWEE POSITION	GENDER	LENGTH OF INTERVIEW
C2E	**e-Commerce**	**Hub**	**25**	**Founder**	**Male**	**90 min'**
c1	e-Commerce	customer	200	Product Development Team Leader	Male	55 min'
c2	e-Commerce	customer	35	Managing Director	Male	45 min'
s1	e-Commerce	supplier	550	Product Manager	Male	30 min'
s2	e-Commerce	supplier	69	Sales Manager	Female	30 min'
3p1	e-Commerce	3rd party	35	General Manager	Male	45 min'
com1	e-Commerce	competitor	200	Product Development Team Leader	Male	55 min'
3p2	e-Commerce	3rd party	30	Service Manager	Male	30 min'
jv1	e-Commerce	joint venture	80	Engineer	Female	60 min'
c1-1c	e-Commerce	customer's customer	300	Marketing Specialist	Male	45 min'
c2-1s	e-Commerce	customer's supplier	25	General Manager	Male	30 min'
s2-1s	e-Commerce	supplier's supplier	150	Purchasing Specialist	Female	35 min'
s2-2c	e-Commerce	supplier's customer	20	Marketing Director	Male	30 min'
C4T	**Tourism**	**Hub**	**10**	**CEO and Marketing Director**	**Both Female**	**95 min'**
c1	Tourism	customer	80	Marketing Manager	Male	30 min'
c2	Tourism	customer	100	Front Desk Manager	Male	50 min'
c3	Tourism	customer	150	General Manager	Female	45 min'
s1	Tourism	supplier	25	Service Manager	Female	55 min'
jv1	Tourism	joint venture	55	Partner	Male	45 min'
3p1	Tourism	3rd party	25	Consultant	Female	40 min'
3p2	Tourism	3rd party	80	Marketing Specialist	Female	60 min'
d1	Tourism	distributor	50	Marketing Director	Female	50 min'
c1-1c	Tourism	customer's customer	6	Hotel Chain Manager	Female	30 min'

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

Figure 1: Three-Phased Snow-Balling Research Approach
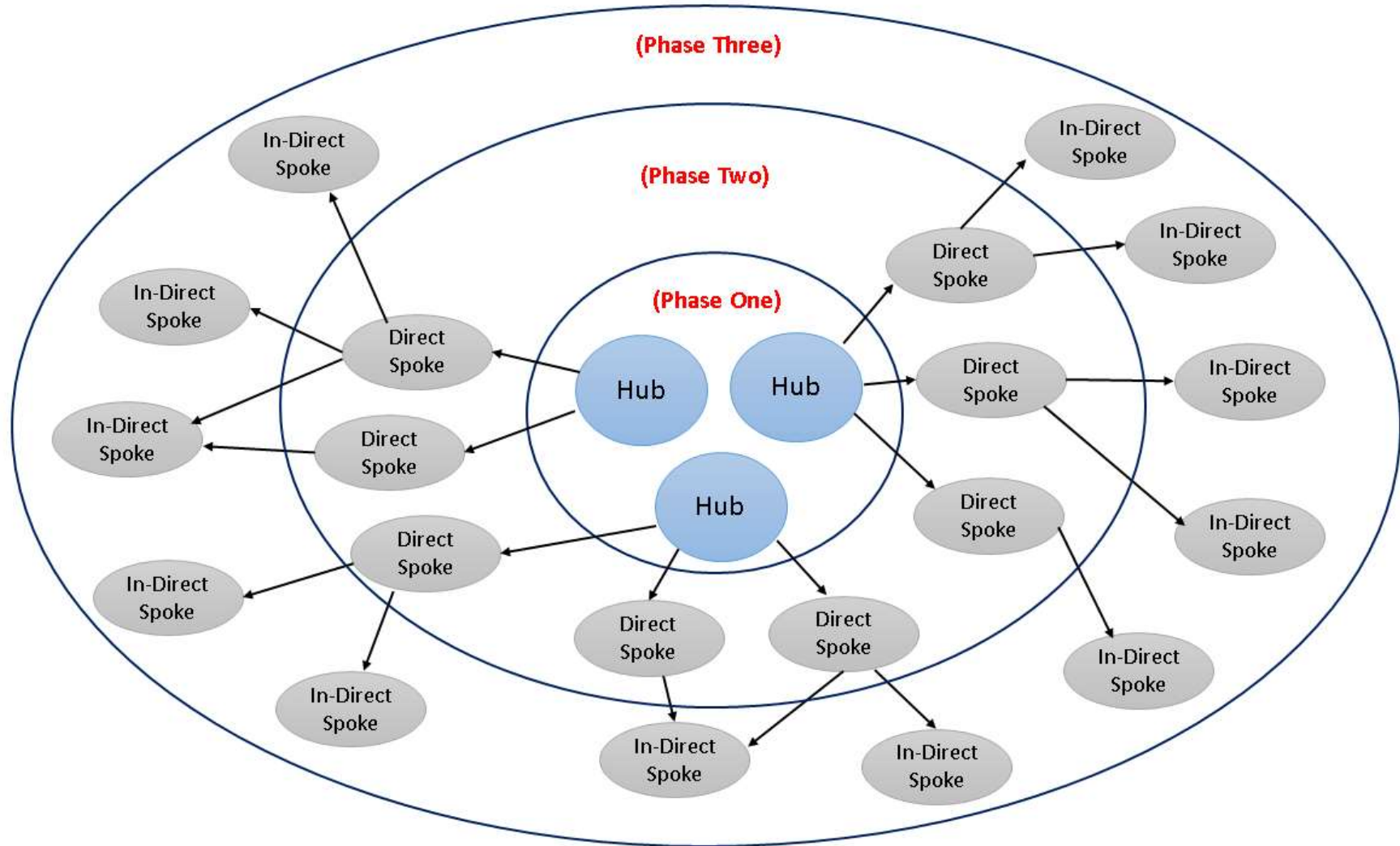
Figure 2: Syndicated Mode in NPD Network Learning

Business Network Partners
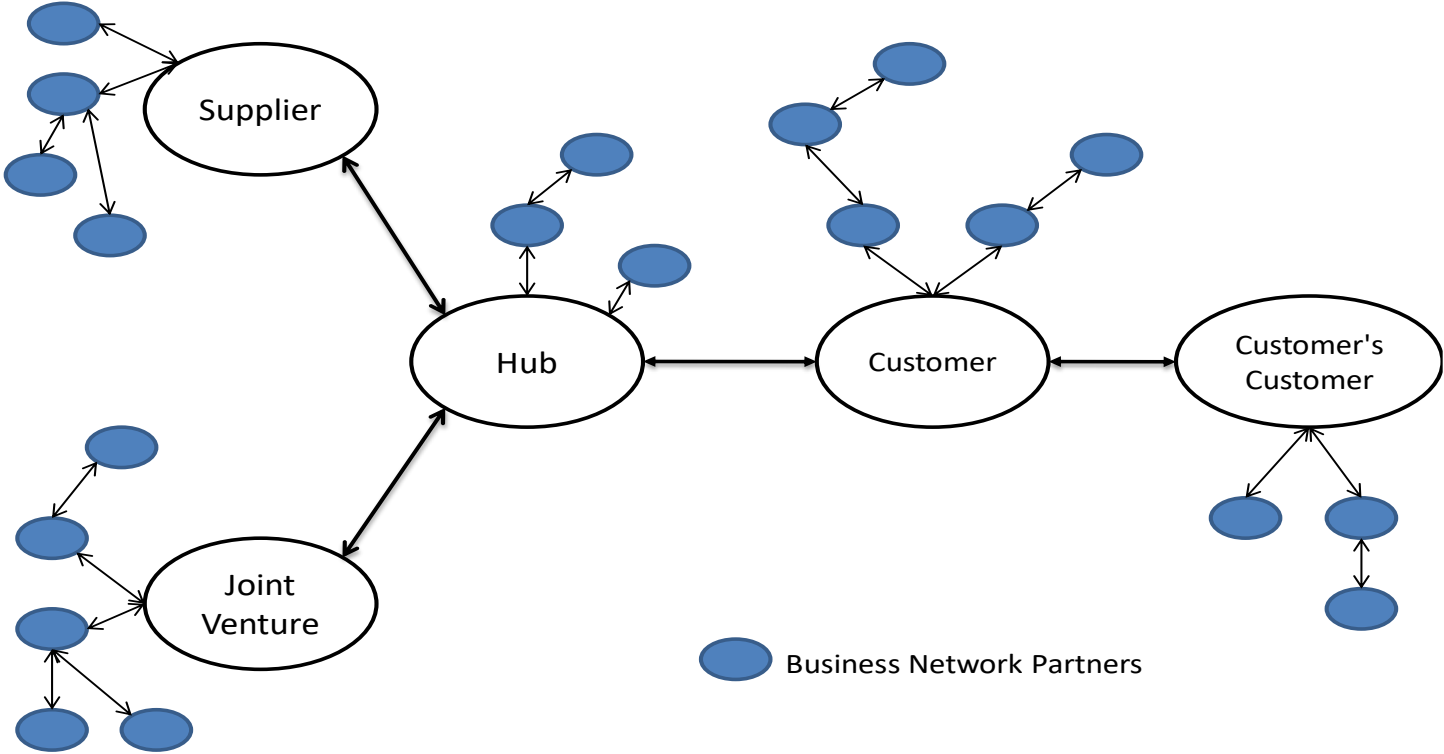
Figure 3: An NPD Network Learning Model in a Loop

Previous NPD Network Learning | Idea Generation Stage | Product Development Stage | Product Launch Stage

Syndicated Mode

Learning actors join two opponent learning approaches (i.e. exploitation and exploration, reactive and proactive) together in a syndicate.

Situated Mode

Learning actors work together either physically or virtually to better understand each other in order to turn tacit knowledge into explicit

Selected Mode

Learning actors learn with selective network partners to avoid issues such as opportunist or free-ride behaviour.

Synergised Mode

- Pollination
- Transformation

Synergised Mode

Learning actors integrate learning from different NPD network partners (from prior or current projects) to enjoy the benefits from collective advantageous knowledge conjunction.

Future NPD

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