CHAPTER 1

INTRODUCTION

CHAPTER ONE

1.0 Introduction

1.1 The Aim of the Study

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1.3 The Research Approach

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1.0 INTRODUCTION

This chapter aims to discuss the background and the scope of the thesis. It contains five major parts: (1) the aim of the study; (2) the objectives of the research; (3) the research approach; (4) the contribution of the study; and (5) the structure of the thesis.

1.1 THE AIM OF THE STUDY

The point of departure of the thesis is that although much evidence exists that new product development (NPD) is an outcome of network collaboration and a result of inter-firm learning, the question of how firms learn about new product development in their business networks is much less understood. NPD has been viewed as the most knowledge intensive process aiming for uncertainty and time reduction, and business networks have become a persistent organisational phenomenon in this process (Hallikas et al. 2009; Kodama 2006; Rittern and Gemunden 2003; Moorman and Rindfleisch 2001; Appleyard 2003; Kodama 2006; Appleyard 2003; Moenaert and Souder 1990; Eisenhardt 1989). The crucial characteristics of new product development networks are drawn on the knowledge-based perspective which stresses using learning networks to enable competence development (Håkansson 1984/2006; Anderson, Håkansson, and Johanson 1994; Ford et al. 2006; Pyka 2002; Bassant et al. 2001; Powell et al. 1996; Andersson and Dahlqvist 2001; Rindfleisch and Moorman 2001; Dyer and Nobeoka 2000).

Despite business network learning being claimed as an important managerial practice in new product development, the literature does not provide a clear explanation of how this learning takes place in firm's business networks when developing products. The literature of learning has shed some light on how learning takes place in business relationships, especially in inter-firm learning. For example, the theory of information processing and knowledge management highlights the mechanisms of acquisition, assimilation, and application (Cyert and March 1963; Daft and Weick 1984; Huber 1991; Cohen and Levinthal 1990; Sinkula 1994; Slater and Naver 1995;

Inkpen 1996; Teece et al. 1997; Day 2002; Beamish and Berdrow 2003). The theory of SECI (socialisation, externalisation, combination, and internalisation) (Nonaka 1994) and the knowledge management model (articulation, extension, assimilation and dissemination) (Hedlund 1994) have helped the understanding of critical firm's engagements in the learning process. A three-step model (transfer, transformation, and harvesting) (Beamish and Berdrow 2003) emphasises the importance of dialogue, integration, and shared meaning in inter-firm learning. Are existing theories appropriate to explain business network learning in new product development? Is there a better model to better understand how product development network learning takes place? Answers remain unknown. In light of these limitations, the aim of the thesis is to explore how firms learn about NPD in their business networks by addressing the following research questions:

(1) How is business network learning processed in NPD?
(2) How do firms engage with their business alliances in the NPD network learning process?
(3) How does the network learning mechanism impact on NPD uncertainty reduction and speed-to-market?

The use of networks is not a guarantor of NPD success. Network learning in NPD often does not achieve its original goals, and many fail (Håkansson and Johanson 2001). The cost of failure can be tremendous. It is difficult to improve it without knowing how it works. The present study aims to contribute to this area.

1.2 THE OBJECTIVES OF THE RESEARCH

In reaching the aim of the study, the objectives of the research are as below:

1. To empirically investigate industrial practice on how business network learning is processed in successful new product development;
2. To empirically investigate industrial practice on how firms engage with their business alliances in the business network learning process;

3. To empirically investigate industrial practice on how the NPD network learning impacts on uncertainty reduction and speed-to-market.
4. To propose a theoretical model of business network learning in new product development from the empirical evidence;
5. To empirically test the proposed theoretical model with a large sample;
6. To empirically examine the impacts of the NPD network learning on uncertainty reduction and speed-to-market in new product development.
7. To contribute theoretical conclusions and practical recommendations from the integrated theoretical studies and empirical evidence.

1.3 THE RESEARCH APPROACH

Based on both the nature of the present study's research aim and objectives, a mixed-methods research approach is used (Creswell 2003). In acquiring an understanding of professional practices of how firms learn about new product development in their business networks, an exploratory multiple-case study is first envisaged. In examining the propositions proposed by the case study results, survey research is then employed. The intent of the phased design is that the results of the first method (qualitative) develop theory that can be tested by the second method (quantitative) (Creswell 2003). Creswell (2003) terms this approach as 'sequential exploratory strategy' to highlight its usefulness for exploring phenomena when study variables are not known, as well as for refining and testing an emerging theory (Morgan 1998) which is the case of the present study. Details will be discussed in Chapter 6.

Multiple-case study is a powerful means in building theories because they allow replication and extension among individual cases (Eisenhardt 1991; Yin 2003). The use of multiple-case study permits the researcher to conduct the study in an interactional networked dimension, providing a platform for the researcher to cross-check data collected not only from different industries perspective but also from different networked partners' points of view. For these reasons, the multiple-case study is selected as an appropriate research approach for qualitative data collection. Survey research enables researchers to examine proposition and to provide

generalised results by large samples. In testing the propositions proposed from the exploratory case study, a survey research is used. As to the data collection techniques, in-depth interview is selected as the main technique combing the techniques of observation and documents to collect qualitative data; and questionnaire is used for quantitative data collection. In conducting exploratory research, data analysis is a critical and complex process. In doing data analysis of multiple-case study, this study employs the 'pattern match' approach suggested by Eisenhardt (1989) and Yin (2003), involving steps of analysing within-case data and searching cross-case patterns to shape propositions. Major themes are emerged from empirical evidence and propositions are suggested from repeated matched patterns. In testing the suggested propositions, this study uses covariance based structural equation modelling (SEM) in dealing with the set of interrelated relationships (Hair et al 1998). Interpretation is a critical element of the data analysis process. To reach a sound interpretation, the researcher integrates and iteratively compares qualitative and quantitative findings with the existing literature (Pentland 1995).

Qualitative research generates a wealth of data, yet validity and reliability tend to be a challenge. This study adopted several case study tactics (Yin 2003) to tackle these issues. For quantitative method research, the methodological soundness is examined and reached by using techniques of testing multivariate assumptions (e.g. normality, linearity) and running confirmatory factor analysis (CFA) (Hair et al 1998). In short, the mixed-method research approach best enables the researcher to explore empirical phenomena, to develop and to test theory, hence is selected as the appropriate research approach for this study. Figure1.1 illustrates this study's research approach:

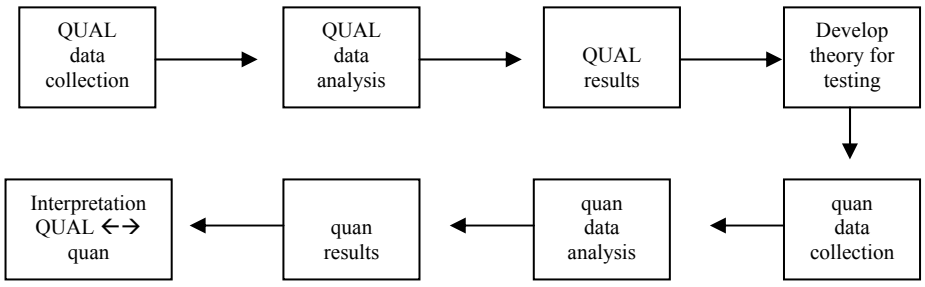


Figure 1.1: Research Approach (Source: Author)

1.4 THE CONTRIBUTION OF THE STUDY

By an exploratory study into an under-researched topic area, the thesis contributes to the knowledge in NPD network learning. A model is built up from empirical evidence in understanding NPD network learning mechanism. The contribution of current research lies in different aspect both in theory and in practice. First, this study contributes to the literature by investigating learning in business networks, an under-researched area. Much of the relevant research has helped to the understanding on learning in dyadic relationships. Nevertheless, the study in dyadic relationships is no longer sufficient to help companies to deal with challenges in NPD collaboration. Building on empirical evidence, current research complements to current understanding in NPD network collaboration.

Second, current research contributes to the literature not only by providing further evidence to related theories and key assumptions in extant research, but it also clarifies and reconciles contradictory views in the existing literature. For example, the current study reconciles the contradictory views between information-processing approach and interpretive approach and thus deepens the insights of how knowledge transfer is carried out in successful NPD projects. By better understanding of how firms learn about new product development in their business networks, current research deepens the insights of how to increase the value of product innovation network collaboration. Details are discussed in the following chapters.

Further, the present study contributes to the methodological literature. Despite the availability of mixed-method related books, chapters, journal papers, virtually nothing has been written about mixed methods in NPD, specifically in NPD network learning. By demonstrating a mixed-method research design, it broadens the scope in doing research in the areas of NPD, business networks and learning. Doing research in business networks (especially in data collection) is not an easy task due to its 'network' nature (Håkansson and Johnson 2001). For scholars who are interested in doing research in related areas, the snow-ball approach with a hub-and-spoke structure suggested in the present study can be one of the solutions to consider. This

study contributes to the data collection method in doing business network study. Details will be discussed in Chapter 6.

Finally, the study contributes to managerial practices. Business network learning often does not achieve its original goals and many fail (Håkansson and Johanson 2001). The cost of failure can be tremendous. The present study, by investigating successful NPD projects, contributes a practical model to companies that attempt to apply business network collaboration to achieve their NPD success. Managers are urged to consider building the proposed NPD network learning model and the advices for its implementation into their company philosophy, corporate culture and employee training programs.

1.5 THE STRUCTURE OF THE THESIS

To achieve the research objectives outlined earlier, this thesis comprises nine chapters. Each chapter is summarised as follows:

Chapter One, the current introductory chapter, discusses the background and the scope of the thesis in its aim and objectives, summarises the adopted research approach to achieve the aim and objectives, unfolds the contribution of the study, and finally outlines the structure of the thesis.

Chapter Two reviews the literature in new product development. The literature of new product development is massive and complex. For a systematic and more comprehensive review, this study employs various guidelines suggested in the literature. The five NPD models help to explain the product development process (Saren 1984). The six research themes guide the review of NPD studies from the topics of strategy, company characteristics, management, process, people and information (Craig and Hart 1992). Finally, the three research streams lead the NPD literature review from integrated views of rational planning, problem solving, and communication web (Brown and Eisenhardt 1995). The researcher iteratively cross-checks related studies in the temporal boundaries between 1969 and 2009. This

chapter concludes by discussing the research implications in regard to this study and unfolds the need for further review the literature of business relationships and inter-firm learning.

Chapter Three reviews the literature of business relationships. It first reviews the literature concerns inter-firm (a dyadic) relationships. It then reviews the related studies into the embeddedness context that helps to construct a better comprehension between inter-firm relationships and business networks. It finally reviews the studies in relating to business networks. This chapter concludes by highlighting the importance of learning networks that enable competence development in NPD.

Chapter Four reviews the literature of learning. The literature into the topic of learning is vast. The present study concerns how learning takes place in the business markets, the learning process is hence of the most interest. The chapter first reviews the related studies in firm's and inter-firm learning process, followed by the studies in business network learning process. Emerging from the literature review and empirical evidence in chapter 7 and 8, several themes require further review in the related literature and are added latter in this chapter. This chapter concludes by summarising process studies from firm's learning to inter-firm learning and business network learning.

Chapter Five provides a synthesised view based on the discussion in the preceding literature review, identifying research gaps rooted from the conclusion of the literature review. In reducing the research gaps, research aim and research questions are detailed. This chapter concludes by proposing a conceptual framework for the study.

Chapter Six discusses the research methodology. It first discusses the philosophical stance and how the research orientations are shaped. It then details various research designs, followed by discussing the approaches of data collection and data analysis and how the methodological soundness can be achieved. After the general

discussion, each section is detailed respectively by discussing the adopted approach(s) for the study.

Chapter Seven discusses and reports the results of the qualitative method research – a multiple-case study. It first summarises the case study design and implementation, followed by detailing the approaches of data collection, examining and analysis used in this study. It then reports the results and findings of the study. As a result, five propositions are suggested.

Chapter Eight discusses and reports the results of the quantitative method research – a survey research. It first specifies the propositions and their incorporated hypotheses. In the study, a mediating effect (proposition 6) was detected and assessed. Six propositions drawn from the case study findings lead to their corresponded hypotheses for testing. It then turns to discuss the proposed constructs, the derived survey instruments, and the operational procedures. Data collected from the survey research are first examined before analysis. This chapter concludes by summarising the test results of the covariance based structural equation modelling.

Chapter Nine aims to conclude the research endeavour by presenting an discussion of the overall study. It first integrates the findings from case study that explores empirical phenomena and from survey research that examines the proposed propositions. It then compares empirical evidence with the extant literature and discusses the integrated conclusion. Theoretical and managerial implications, limitations of the study and directions for future research are presented at the end of the chapter.

Figure 1.2 illustrates the structure of the thesis:

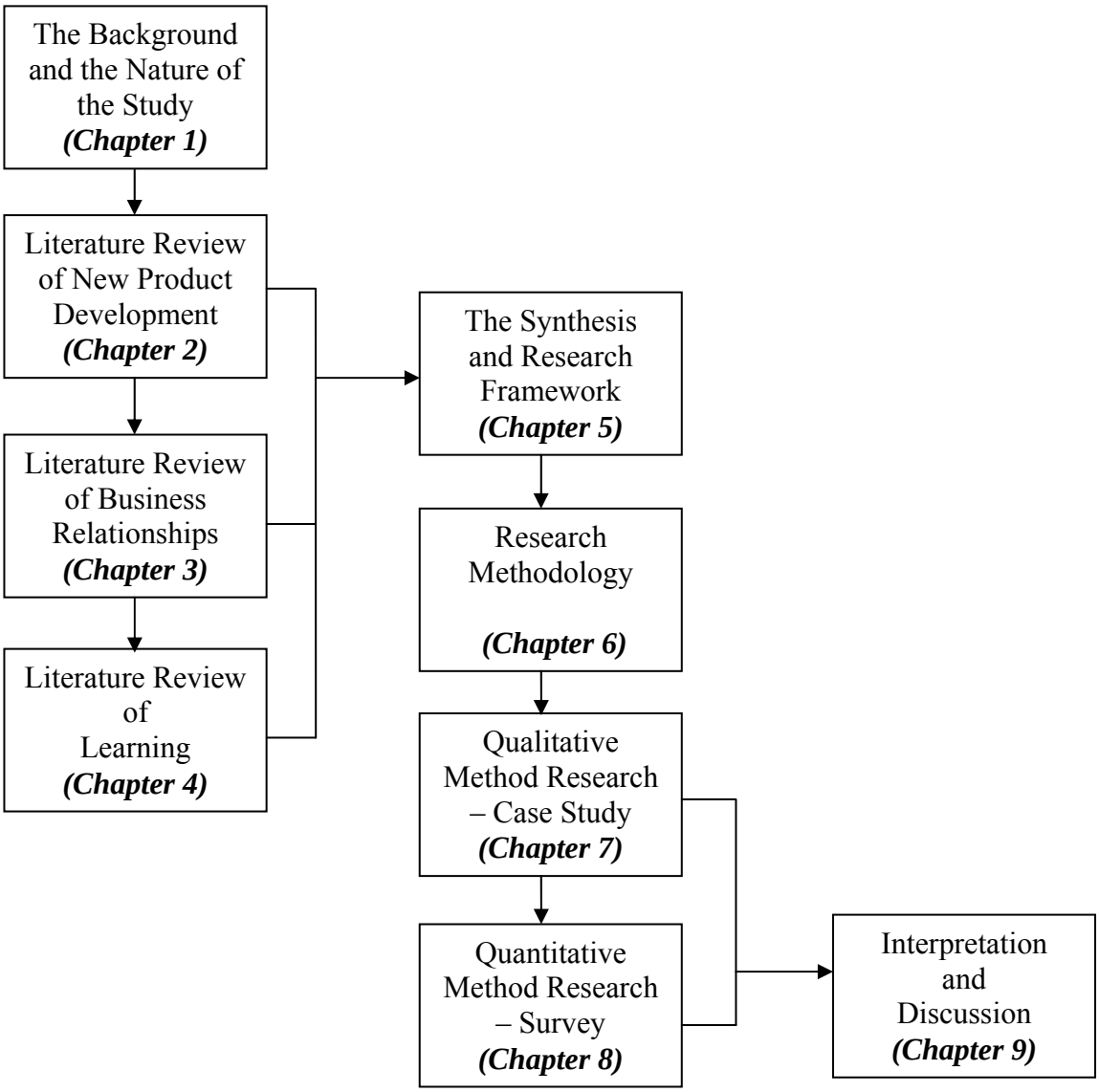


Figure 1.2: The Structure of the Present Thesis (Source: Author)

CHAPTER 2

NEW PRODUCT DEVELOPMENT

CHAPTER TWO

2.0 Introduction

2.1 A Product

2.2 A New Product

2.3 New Product Development (NPD)

NPD Models

Major NPD Research Themes

Integrative NPD Research Streams

2.4 Implications to This Study

2.5 Conclusion

2.0 INTRODUCTION

This chapter reviews the literature of new product development (NPD). It first seeks the understanding of *a product* and of a *new product*. It then reviews the NPD literature. The literature in NPD is massive and complex, ranging from broad-brush explorations to in-depth case studies and across many types of products, firms and industries. For an organised and systematic approach, the review used various guidelines suggested in the literature. The five NPD models reviews NPD; the six NPD research themes guide the review from the topics of NPD strategy, company characteristics, management, NPD process, people and information; and the three NPD research streams lead the review from integrated views of rational planning, communication web and disciplined problem solving. The researcher iteratively cross-checks related studies in the temporal boundaries between 1969 and 2009. This chapter is concluded by discussing the implications of the review results to the present study.

2.1 A PRODUCT

What is a product? A product can be viewed from a multi-dimensional concept (Cooper et al. 2004, Trott 2008). A product can be defined differently and can take many forms. One perspective derives from tangible and intangible product features (Baker 2006; Hultink et al. 2000). From this view, many commercialised product in the market has a tangible component as well as an intangible one. Intangibility is probably the single most important factor in distinguishing services from goods (Baker 2006). Another perspective of core concept of product concerns the exchange between customer and suppler. Jobber (2004), from a customer perspective, has defined a product as anything that is capable of satisfying customer needs. Baker and Hart (2007) view the product as the object of the exchange process, the thing which the producer or supplier offers to a potential customer in exchange for something else which the supplier perceives as of equivalent or greater value. Kotler (2001) sees a product as anything that can be offered to a market for attention, acquisition, use or consumption that might satisfy a want or need. It includes

physical objects, services, persons, places, organisations and ideas. In marketing literature, the term 'product' can be grouped into three levels. The first level comprises the basic benefits or satisfactions that a particular product delivers, that is, the core benefit or service (Jobber 2004, Baker and Hart 2007). The second level leads to the categories of tangible and intangible. A product may possess the linkages between the physical product attributes (tangible, e.g. packaging) and subjective satisfactions (intangible, e.g. brand name) (Hultink et al. 2000, Trott 2008). The third level refers to the augmented or extended product, which is the broader set of marketing elements within which the product exists, e.g. warranty, after sales service (Cooper et al. 2001). Figure 2.1 illustrates the levels of product.

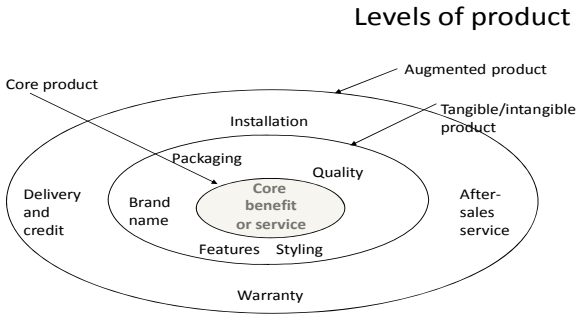


Figure 2.1: Levels of Products (Source: Kotler 1989)

2.2 A NEW PRODUCT

What is a new product? Jobber (2004) defines new products as those ones that are fundamentally different from products that already exist. In this sense, new products reshape markets and competition. Rogers and Shoemaker (1972) argue that it may be difficult to establish whether a product is actually new as regards the passage of time, so long as it is perceived to be new it *is* new. This is significant because it illustrates that newness is a relative terms. In the case of a new product it is relative to what preceded the product. In fact, a majority of so-called new products are developments or variations on existing formats. Research in this area suggests that only about 10 percent of new products introduced are new to both the market and the company (Booz, Allen and Hamilton 1982; Cooper et al 2001). New to the company means that the firm has not sold this type of product before, but other firms could have. New to the market means that the product has not appeared before in the

market. There have been many attempts to classify new products into certain categories (e.g. Story et. al 2001; Calantone et al. 1996; Kuczmarske 1994). The following classification (Booz, Allen and Hamilton, 1982) identifies the commonly accepted categories of new products.

New-to-the-world products

They are the first of their kind and create a new market. They are inventions that usually contain a significant development in technology, such as a new discovery.

New product lines (new to the firm)

These products are new to the particular company. They provide an opportunity for the company to enter an established market for the first time.

Additions to existing lines

This category is a subset of new product lines above. The distinction is that while the company already has a line of products in this market, the product is significantly different from the present product offering but not so different that it is a new line.

Improvements and revisions to existing products

These new products are replacements of existing product in a firm's product line. Often, new products come from numerous modifications over time and, with each revision, performance and reliability have been improved.

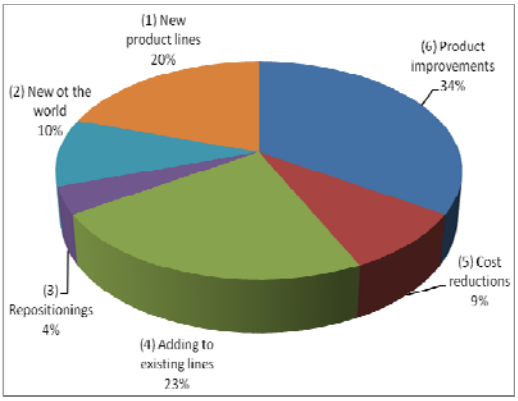
Cost reductions

This category of products may not be viewed as new from a marketing perspective, largely because they offer no new benefits to the customer. From the firm's perspective, however, they may be very significant. Indeed, frequently it is this category of new product that can produce the greatest financial rewards for the firm. Improved manufacturing processes and the use of different materials are key contributing factors.

Repositioning

These new products are essentially the discovery of new applications for existing products. This has as much to do with consumer perception and branding as technical development.

In practice, it is found that a majority of new products are contributed from products already in the market, additions to existing lines, and products new to the firm but already manufactured by competitors (new product lines) (Griffin 1997). In a research on new product development practices, Griffin (1997) has found that almost 70 percent of new products are improvements (34%), cost reductions (9%) and additions to existing lines (23%). It is also found that the higher the newness involved in a new product, the higher the uncertainty and risk is. Figure 2.2 illustrates the details.



(1) New product lines (20%)
(2) New to the world (10%)
(3) Repositioning (4%)
(4) Adding to existing lines (23%)
(5) Cost reductions (9%)
(6) Product improvements (34%)

High uncertainty, High risk

Low uncertainty, Low risk

Figure 2.2: New Product Categories (Source: Griffin 1997)

2.3 NEW PRODUCT DEVELOMENT (NPD)

Over years, the pace of new product development research has quickened as numerous academic scholars have probed the secrets of NPD prowess (e.g. Nelson

and Winter 1977; Dosi 1988; Brown and Eisenhardt 1995). This area of research is almost as numerous as the number of articles which have been written that has led to a complex body of literature. Research into NPD takes place within many different intellectual and functional domains, including marketing, technology management, R&D strategy, innovation management, organisational studies, to name but a few. To present the literature review into the massive NPD studies, the study borrows various guidelines suggested by the literature. This section first discusses a general review guided by five types of NPD models (Saren 1984) and six major research themes (Craig and Hart 1992), followed by an integrated review under three major research streams (Brown and Eisenhardt 1995). Related studies in the temporal boundaries between 1969 and 2009 were iteratively cross checked.

NPD Models

In studying NPD, it is possible to classify the numerous models into distinct categories: departmental-stage models; activity-stage models; decision-stage models; conversion-process models; and response models (Saren 1984). Departmental-stage models view the development of new product where each department is responsible for certain tasks. This kind of models have been criticised as 'pass-the-parcel' (Hart and Baker 1994) or 'over-the-wall' approach (Trott 2008), so called because departments would carry out their tasks before throwing the project over the wall (or like pass the parcel) to the next department. Biemans (1992) argues that such models failed to learn the lessons from the whole process into success and failure in NPD. Activity-stage models emphasise activities conducted in developing new products. They provide a better representation of reality than departmental-stage ones in that activity-stage modes facilitate iteration of the activities through the use of feedback loops, something that the departmental-stage models do not (Crawford 1997). A good example is the BAH (1982) model that represents the major elements of many activity-based models. Another good example is the model suggested by Cooper (1988) who claims that predevelopment activities determine new product success. Cooper found that those firms which successfully launched new products were more likely to have had a formal activity planning process in place for a longer period of

time. Although the activity-stage model is a commonly accepted and useful model (Hart and Baker 1994), they are criticised as a continuing pass-the-parcel approach to NPD. The activities are still seen to be the responsibility of separate department or functions (Carbonell-Foulquie et al. 2004).

Continuing the thread of the activity-based models, Decision-stage (or stage-gate) approach is widely employed in new product development. It has been popularised by Robert Cooper‘s research in this area (Cooper et al. 1986, 1991). Decision-stage models represent the new product development process as a series of decisions that need to be taken in order to progress the project. This type of models demonstrates the NPD process as a series of evaluation points, where the decision to go or not go the project is made (Hart et al. 2003). These modes underline feedback loops that the previous two modes do not have. However, a criticism of these models is that the importance of the interaction between functions cannot be stressed enough (Trott 2008). Conversion-process models view new product development as numerous inputs into a ‘black box’ where they are converted into an output (Schon 1967). To avoid the imposed rationality of departmental-based, activity-based and decision-based models, the conversion process is a collection of unspecified tasks which may or may not be carried out, depending on the nature of the innovation (Cooper 1985). A series of inputs may be composed of information on customer needs, or an alternative manufacturing procedure. This type of models stresses the concept of a variety of information inputs leading to new product success. Response models are based on the work of Becker and Whistler (1967) who used a behaviourist approach to analyse change. In characterises the perception-search-evaluation-response iteration, and focuses on individuals’ or organisation’s response to change.

Synthesis

To grasp what is known, the NPD literature review is first discussed by employing a template of five NPD models (Saren 1984). There has been many versions of NPD models, for example those of Booz, Allen and Hamilton (BAH 1982); Cooper (1988); Hart and Baker (1994). Empirically, there is always a process by which each new product is created and commercialised. In short, NPD can be viewed as a set of

activities that lead to a successful new product launch (Cooper 1988; Hultink et al. 2000). Such activities are usually listed as a series of NPD models and every model has its strengths and weaknesses. Department stage models highlight the responsible NPD tasks in each department; but fail to learn the lessons from the whole process. Activity-stage models emphasis the iteration of NPD activities, but have been criticised as a continuing pass-the-parcel approach. Decision-stage models concern the decisions for NPD progress, but ignore the interaction between functions. Conversion-process models look into the input and output and stress the importance of customer information and operation procedure. Finally, the response models focus on individuals or organisation's response to change that leads to the development of a new product. Table 2.1 summarises the discussion:

NPD Models	Description	Seminal/Important Research and Studies
Department Stage	These models view the development of NP where each department is responsible for certain tasks.	Saren (1984); Hart and Baker (1994); Trott (2008)
Activity-Stage	These models emphasis the iteration of activities in NPD such as through the use of feedback loops.	Booz, Allen and Hamilton (BAH) (1982); Cooper (1988); Crawford (1997)
Decision-Stage	(or stage-gate) These models take a series of decisions for the progress of NPD	Cooper et al. (1986; 1991); Hart et al. (2003)
Conversion-Process	These models view NPD as numerous inputs into a 'black box' where they are converted into an output. Customer information and operation procedure are viewed as input that lead to NP success.	Schon (1967); Cooper (1985)
Response	These models used a behaviourist approach and highlight the perception-search-evaluation-response iteration.	Becker and Whistler (1967)

Table 2.1 (Source: Author)

Major NPD Research Themes

The importance of successful NPD has led many researchers to seek to determine the ingredients of new product successes. In so doing, researchers have attempted to provide those involved in NPD with normative theories to guide them in the best practice of NPD. Many research studies have sought to identify the critical success factors in NPD. They have approached this task by specifying a set of variables and measuring the relationship between these variables and the outcome of NPD activities. As a consequence, similar variables are examined throughout the NPD research. Six themes are identified by focusing on both overlapping and complementary sets of variables: NPD strategy, company characteristics, management, NPD process, people, and information (Craig and Hart 1992). As a cross-check against the burgeoning network of citations, the researcher iteratively returned to the journals in the temporal boundaries between 1969 and 2009 with special attention on studies related to the research topic.

NPD Strategy

The literature under the strategy theme claims that successful NPD needs to be led by corporate strategy and suggests how companies can best develop new product strategies (e.g. Crawford 1980; Cooper 1984; Bart 2002; Garcia and Calantone 2002; Wagner and Hansen 2005). A number of articles argue that NPD must be guided by the corporate goals and there is a need to set clearly difined objectives for NPD projects (Kortge and Okonkwo 1989; Goltz 1986; Bart 2002; Garcia and Calantone 2002). For example, Wagner and Hansen (2005) have stressed that corporate innovation strategy is one of the key assets for a small company to compete to a large company. Rink and Fox (2003) urged managers to develop and implement strategies for different functions within the company for a new product success. Edward (2001) suggested management that matching project structure to corporate strategy helps team members buy in and establish commitment for NPD. Under this theme, corporate innovation strategy, merge technology and marketing strategies and matching project structure to corporate strategy are most associated with successful NPD.

Company Characteristics

This group of scholars studied a number of company characteristics as determinants for success in NPD; within which, organisational structure and style are two important topics drawn much scholars research attention (e.g. Bentley 1990; Rothwell and Whiston 1990; Christensen, Magnusson and Zetherstrom 2006; Cordon-Pozo, Garcia-Morales and Argon-Correa 2006; Charter and Clark 2008). This group of studies suggests that a decentralised and flexible structure that encourages collaboration and integration is most conductive to NPD success. Charter and Clark (2008) have claimed that organisational structure will need to be created that enable learning and change in a dynamic setting for better product development. In recent years, using collaborative product development systems have been much studied under the topics of organisational structure and style for better NPD (Christensen, Magnusson and Zetherstrom 2006; Cordon-Pozo, Gracia-Morales and Argon-Correa 2006). Under this theme, integrative mechanisms, good communications systems, decentralised systems of control, problem solving and risk taking have been associated with high NPD performance.

NPD Management

NPD management has drawn scholars' attention, especially on the strategic level of management. Managerial orientation, top management involvement, and top management roles are key issues that have been studied under this theme (e.g. Maidique and Zirger 1984; Cooper 1987; Hart and Service 1988; Calantone, Garcia and Droge 2003; Brentani and Salom 2007; Rodriguez, Perez, and Guiterrez 2008). Kleinchmidt, Brentani and Salomo (2007) claimed that top management involvement plays a significant role in building up company's global NPD process capabilities. Rodriguez, Perez, and Gutierrez (2008) examined the marketing-R&D relationship at different levels of management commitment and concluded that top management commitment enhances the importance of effective cross-functional communication flows for new product performance. Calantone, Garcia and Droge (2003) studied top management risk taking and claimed that managers should recognise the uncertainty

involved in NPD and risk-taking orientation are associated with the NPD success. Under this theme, top management plays a critical role in prompting NPD success.

NPD Process

The NPD *process* represents the formation to bring a new product from an idea or opportunity, through to a successful market launch. Studies on various NPD process have produced a wealth of literature on the subject (e.g. National Industrial Conference NICB 1964; Rothewell project SAPPHO 1972; Cooper 1979; Peters and Wateman 1982; Booz, Allen and Hamilton (BAH) 1982; Crawford 1983; Cooper 1988; Cooper and Kleinschmidt 1991; Hart 1993; Tzokas et al. 2004). A significant part of the literature focuses on (1) the activities within the NPD process, in which uncertainty reduction and NPD cycle time are tightly related (e.g. Souder and Moenaert 1992; Moorman 1995); (2) cross-functional coordination in NPD process (e.g. Jassawalla and Sashittal 1999; Tzokas et al. 1997; Calantone and Durmusoglu 2007); (3) a simultaneous rather than sequential approach in the process of developing new products (e.g. Hart 1993; Cooper, Kleinschmidt and Elko 1995). The NPD process represents the formation to bring a new product from an idea or opportunity, through to a successful market launch. Studies on various NPD processes have produced a wealth of literature on the subject (Booz, Allen and Hmilton (BAH), 1982; Crawford 1983; Cooper 1988; Cooper and Kleinschmidt 1986; Hart 1993; Baker and Hart 1999). The organisational activities undertaken by the company as it embarks on the actual process of new product development have been represented by numerous different modes. These have attempted to capture the key activities involved in the process, from idea to commercialisation of the product. A widely known example being that of Booz, Allen and Hamilton (1982), which is shown below:

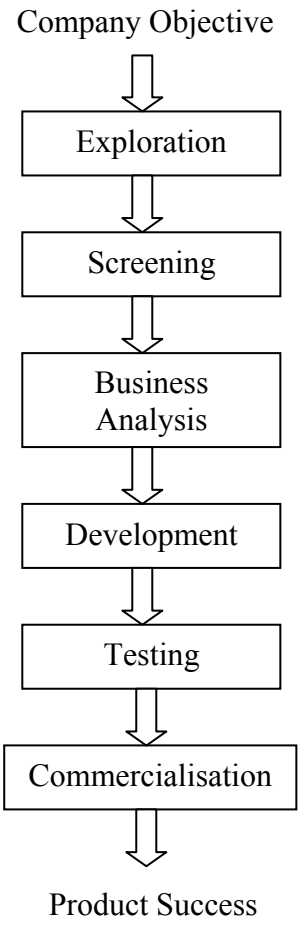


Figure 2.3: NPD process (Source: Booz, Allen and Hamilton 1982)

The activity staged processes have also developed into those focusing on the stages of decision taken after each set of activities, and major exemplars of these models include PACE (Product and Cycle Time Excellence) and the Stage-Gate system devised by Cooper and his colleagues. PACE model emphasises a systematic approach to concept evaluation and managing the embryonic stages of product development (McGarth, Shapiro and Anthony 1992). The Stage-Gate system serves the function of evaluation which the performance of the product development effort can be evaluated and adjustments made (Cooper and Kleinschmidt 1991). These processes consist of stages of activity, followed by review points, or gates, where the decision to continue (or not) with the development is made. Figure 2.4 illustrates this concept:

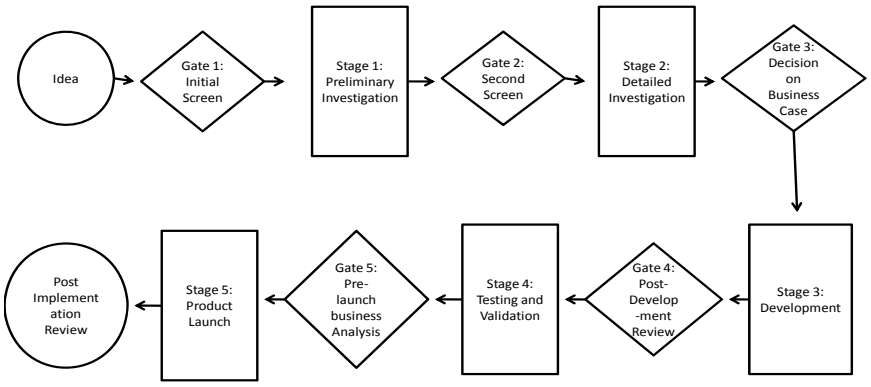


Figure 2.4 (Adopted from Cooper and Kelinschmidt 1991)

Virtually all those involved with the development of new products dismiss such simple linear models are not being a true representation of reality. Research suggests that the process needs to be viewed as a simultaneous and concurrent process with cross-functional interaction (Hart 1993; Cooper, Kleinschmidt and Elko 1995; Griffin and Hauser 1996; Tzokas et al. 1997*).* Cross functional integration, building collaborative cross-functional new product development team has been a topic in many studies (Jassawalla and Sashittal 1999; Gerwin and Barrowman 2002; Hull 2004; Harmancioglu, McNally, Calantone, and Durmusoglu 2007). Jassawalla et al. (1999), in studying building collaborative cross-functional new product teams, highlighted how learning through new product teams interaction improves the effectiveness in NPD process. Harmancioglu et al. (2004) have concluded that cross-functional integration impacts on NPD process design and implementation. Hull (2004) studied a model of product development effectiveness and suggested that interactions in cross-functional teams contribute to successful NPD process. The topic of cross-functional product development team will be elaborated more in the following sections on the themes of 'people' and 'information'.

In studying NPD process, the topics of uncertainty reduction and product development cycle time are tightly related with project activities. The notion of reducing uncertainty as the main objective of the project development activities is reiterated throughout the literature; and information and knowledge are closely

associated with uncertainty reduction (Moenaert and Souder 1990; Rosenberg 1988; Souder et al. 1998; Lievens and Moenaert 2000; Podolny 1994; McDermott and O'Connor 2002; MacCormack and Verganti 2003; Calantone et al. 2006). The NPD process 'can be considered as discrete information processing activities aimed at reducing uncertainty…' (p.92 Moenaert and Souder 1990). As competitive pressure increases and product life cycles compress, companies are trying to shorten product development cycles. A group of scholars focuses on studying product development cycle time and its speed-to-market (Gold 1987; Eisenhardt 1989; Schoonhoven and Eisenhardt and Lyman 1990; Griffin 1997, 2002; Ittner and Larcker 1997; Kessler and Chakrabarti 1999; Filippini, Salmaso and Tessarolo 2004; Appleyard, Brown and Sattler 2006). In studying cycle time and NPD process, three important topics are identified: cross-functional integration, external networks, and knowledge/information. For example, Griffin (1997) and Kessler and Cakrabarti (1999) studied the cross-functional integration in NPD process and concluded that a cross-functional product development team impacts on decreasing cycle time. Crawford (1992) and Gold (1987) argued that external resources and network with customers and supplier help to accelerate NPD process. Eisenhardt (1989) and Schoonhoven et al. (1990) highlighted information and knowledge synthesis reduces NPD cycle time. Denker et al (2001), in studying cycle times, found that information transfer helps developing NPD project plans, removing unnecessary iteration, simplifying project reviews, and improving deliverable quality.

People

A number of studies refer to the people involved in the NPD process and the way in which these people are organised as critical factors in the outcome of new product developments (Myers and Marquis 1969; Maidique and Zirger 1984; Gupta and Wilemon 1988; Moorman 1995). The majority of the studies under this theme consider (1) the co-ordination and integration of the different functions (especially, the coordination of the R&D and marketing functions (e.g. Maidique and Zirger 1984; Cooper, Kleinschmidt and Elko 1995; Tzokas et al. 1997; Calantone and Durmusoglu 2007); (2) the important of information and knowledge and the way it is communicated (e.g. Moenaert and Souder 1996; Griffin 1997; Cooper 2001; Hull

2004); and (3) in more recent studies, innovation networks for information and knowledge dissemination and creation are in the centre of NPD studies (e.g. Powell et al 1996; Pyka 2002; Ritter and Gemunden 2004; Story, Hart and O'Malley 2009).

Moorman (1995) studied organisational market information processes in NPD and suggested that information processes in NPD are fundamentally 'people' processes that involved commitment and trust among organisational members. Studies under this theme concentrated on functional co-ordination, especially of the R&D and marketing functions and of external functional co-ordination in which business networks is of importance, the importance of information and knowledge, and the way it is communicated for successful NPD. For example, Tzokas et al. (1997) argue that R&D activity may be used creatively to enhance marketing and highlight that R&D collaboration is a prime mechanism for getting access to promising new ideas and products. A group of scholars studied the functional coordination as a critical factor contributing to the development of successful new products (e.g. Maidique and Zirger 1984; Hart and Baker 1994; Cooper, Kleinschmidt and Elko 1995; Griffin and Hauser 1996 Gerwin and Barrowman 2002; Hull 2004; Harmancioglu, McNally, Calantone, and Durmusoglu 2007, Rodriguez et al. 2008). In studying functional coordination in NPD, the interaction between R&D and marketing has drawn much research attention (e.g. Rodriguez et al. 2008; Atuahene-Gima and Evangelista 2000; Haggblom, Calantone and Di Benedetto 1995; Lu and Yang 2004; Moenaert and Souder 1990).

As mentioneded above, the process of NPD is one of reducing uncertainty and there is therefore much in need of information. A high level of uncertainty is one of the key causes of the conflict and turbulence at the R&D/marketing interface (Ginn and Rubenstein 1986; Moenaert and Souder 1990). The way in which that information plays an important role is associated with communication. Communication among NPD teams has been studied intensively in individual as well as organisational levels (Rothwell and Robertson 1973; Pinto and Pinto 1990; Moenaert and Souder 1996; Cooper 2001; Morgan 2003; Griffin and Hauser 1992; Moenaert et al. 2000). Pinto and Pinto (1990 p.203) have stated that cross-functional communication is 'the

vehicle through which personnel from multiple functional areas share information that is so crucial to the successful implementation of projects'. Moenaert and Souder (1996) have claimed that 'communication constitutes the lifeblood of NPD teams' in that NPD requires information sharing bet R&D and marketing and company's absorptive capacity depends on the links across a mosaic of individual capabilities.

Functional coordination for NPD is not only driven from internal but also can be derived from external collaboration. In recent years, the topic of innovation network has drawn NPD scholars' research interests (Powell et al. 1996; Pyka 2002; Ritter and Gemunden 2004; Rulke and Galaskiewicz 2000; Akgun, Byrne, Keskin, Lynn, and Imamoglu 2005; Kodama 2006; Calia, Guerrini, and Moura 2007; Story, Hart, and O'Malley 2009). For example, Pyka (2002) has claimed that innovation networks have become a persistent organisational phenomenon in NPD. Calia et al (2007) have studied how the innovation network provides the necessary resources in NPD. In studying innovation networks, knowledge dissemination, knowledge creation are highlighted (Kodama 2006; Emden, Calantone and Droge 2006; Booz, Allen and Hamilton 2004; Rittern and Gemunden 2003; Hellstrom and Malmquist 2000).

Information & Knowledge

A number of the studies in NPD refer to information as a critical factor for success (Cooper 1979; Rothwell et al. 1974; National Industrial Conference Board 1964; Rothwell 1972; Moenaert and Souder 1990; Moorman 1995;; Hart, Tzokas and Saren 1999; Lievens, and Moenaert 2000; Zahay, Griffin, and Fredericks 2003; Hart and Liu 2006). Studies under information theme suggest that (1) information facilitates the efficient NPD process as discussed above (Cooper 1979; Rothwell et al. 1974); (2) information helps to achieve functional coordination as discussed (e.g. Moenaert and Souder 1990; Hart and Baker 1994; Rodriguez et al. 2008); and (3) information is closely associated with uncertainty and cycle time reduction (Souder and Moenaert 1992; Lievens and Moenaert 2000; Macher and Mowery 2009).

The importance of information has been stressed in various research topics. For example, the role which information can play in facilitating an efficient NPD and achieving functional coordination is emphasised throughout the literature (e.g. NICB 1964; Myers and Marquis 1969; Rothwell Project SAPPHO 1972; Hart, Tzokas and Saren 1999; Lievens and Moenaert 2000; Zahay, Griffin and Fredericks 2003; Hart and Liu 2006; Macher and Mowery 2009). (e.g. Souder and Moenaert 1992; Griffin 1997; Eisenhardt 1989). In order to reduce uncertainty and reduce cycle time, it is not sufficient that information be processed; it also has to be transferred between different functions and different sources (Moorman 1995; Souder and Moenaert 1992; Danker, Steward and Browning 2001; Macher and Mowery 2009). Uncertainty can be viewed as a multidimensional construct driven by many sources and thus different sources of information are required. Souder and Moenaert's (1992) study contributed to our understanding on some important sources on product development. Souder and Moenaert's (1992) study indicated there were four major sources of uncertainty: *customer* – which refers to uncertainties about user needs; *technological* – uncertainties about the best technologies to employ; *competitive* – uncertainties about competitors; and *resources* – uncertainties about firms' effectiveness in allocating its human, financial and technical resources. The first three categories of uncertainty originate from what has been considered in general systems theory as the external environment (Katz and Kahn, 1966). Furthermore, the relationship among the first three uncertainties may be interrelated, i.e., if an organisation is uncertain about user needs, and/or about the alternative technologies, it is also uncertain about its competitive position (Abell 1980). The major means at an organisation's disposal to acquire information about each of the above uncertainties are its resources (Souder and Moenaert 1992). Some researchers believe that the more uncertain the organisation is about the market, the technology, or the competition, the more probable that the organisation will be uncertain about the type and the amount of resources it needs (Jauch and Kraft 1986; Milliken 1987). It is also claimed that when internal resources are not sufficient to support uncertainty reduction, external resources will be sought (Lievens and Moenaert, 2000).

The theme of information is also closely related to speed and cycle time in NPD (Eisenhardt 1989; Carmel 1995; Appleyard et al. 2006; Macher and Mowery 2009). For example, Eisenhardt (1989) studies how executive teams make rapid decisions in NPD and found that fast NPD decision makers use more, not less, information than do slow decision maker. Driven from the study of information, knowledge has attracted many scholars' research interests in recent years. For example, Duysters and de Man (2003) highlight that working with alliances helps to acquire information and knowledge in a swift manner, thereby strengthening firms ability to survive the high speed of NPD. Johnson, Piccolotto and Filippini (2009) conclude that market knowledge competence and time performance are related in driving successful NPD. Macher and Mowery (2009) emphasis that the knowledge from a firm level collaboration building the dynamic capabilities that reduce NPD cycle time. In short, *information* has been an important theme studied by many scholars, within which the conclusion that information and knowledge play an important role in facilitating an efficient NPD is emphasised throughout the literature.

Synthesis

Over several decades, the academic community has witnessed a plethora of research studies investigating the determinant of new product success. This has led to a complex body of NPD literature. By reviewing what has been done across disciplines, six major themes in NPD research are identified (Craig and Hart 1992) and borrowed in this review: NPD strategy, company characteristics, management, NPD process, people, and information. The themes of strategy, company characteristics, and management are drawn from the strategic orientation in which corporate goals, flexible organisational structure, collaboration environment, and top management involvement are highlighted. The themes of process, people and information are drawn from the project orientation in which uncertainty reduction, NPD cycle time, cross-functional coordination, and the use and source of information and knolwedge are important areas and are iteratively studied. The review on the project oriented themes leads to an important research area – NPD networks. The literature review suggests that knowledge dissemination and creation are important research topics in studying NPD networks. Table 2.2 summarises NPD studies on

the strategic themes of strategy, company characteristics, and management. Table 2.3 summarises NPD studies on the project themes of NPD process, people, and information.

STRATEGIC THEMES	**Strategy**	**Company Characteristics**	**Management**
Description	The strategic innovation orientation within the firm will influence the outcome of the NPD. That is, NPD must be guided by the corporate goals for the company.	A number of company characteristics as determinants for NPD success.	The role of top management can play in encouraging new product developments.
focus of the Research	The literature under the strategy theme focuses on the need for NPD to be led by corporate strategy and identifies the types of strategic orientations most associated with successful developments.	The studies concentrate on the organisational structure and style, and suggest that a decentralised, flexible structure which encourages collaboration and integration is most conductive to success.	Research focuses on this theme includes the most appropriate managerial orientations, how best to involve top managers in NPD, and which are the most important roles for top managers to play.
Seminal / important research and studies	Crawford (1980); Cooper (1984); Bart (2002); Garcia and Calantone (2002); Rink and Fox (2003); Wagner and Hansen (2005)	Bentley (1990); Rothwell and Whiston (1990) ; Christensen et al. (2006); Cordon-Pozo et al. (2006); Charter and Clark (2008)	Cooper (1987); Maidique and Zirger (1984); Hart and Service (1988); Gupta et al. (1985); Calantone et al. (2003); Rodriguez et al. (2008)

Table 2.2 NPD Studies (I) (Source: Author)

PROJECT THEMES	**NPD Process**	**People**	**Information**
Description	The process of NPD involves the activities and decisions from the time when an idea is generated until the product is commercialised.	The people involved in the NPD process and the way in which these people are organised as critical factors in the outcome of NPD.	Information is a base currency of the NPD process; evaluative information is crucial and all information must be efficiently disseminated to facilitate communication.

focus of the Research	a significant part of the literature focuses on (1) the activities within the NPD process, in which uncertainty reduction and NPD cycle time are tightly related; (2) cross-functional coordination in NPD activities; and (3) a simultaneous rather than sequential approach to developing new products.	The majority of the studies under this theme consider (1) the co-ordination and integration of the different functions in NPD, and in particular the co-ordination of the R&D and marketing functions (2) the importance of information and knowledge and the way it is communicated for successful NPD (3) innovation networks for information and knowledge dissemination and creation.	A number of NPD studies refer to information as a factor critical for success: (1) Information facilitates an efficient NPD process, (2) information helps to achieve functional co-ordination, and (3) information and knowledge is closely associated with uncertainty reduction and speed to market.
Seminal / important research and studies	NICB (National Industrial Conference board (1964); Rothwell Project SAPPHO (1972); Cooper (1979); Peters and Waterman (1982); BAH (1982); Cooper et al. (1995); Calantone et al. (2007)	Johnson (1975); Van de Ven (1976); Argote (1982); Schermerhorn (1986); Gupta and Wilemon (1988); Moenaert and Souder (1990); Cooper (2001); Hart and O'Malley (2009)	NICB (National Industrial conference board) (1964); Myers and Marquis; (1969)Rothwell Project SAPPHO (1972); Lievens and Moenaert (2000); Zahay et al. (2003); Macher and Mowery (2009)

Table 2.3 NPD Studies (II) (Source: Author)

Integrative Research Streams

The above NPD themes help a systematic review on the vast NPD literature. Through the review, it reveals that various themes are often inter-related and research streams with inter-related themes are disclosed. For this review's breadth and depth, three main NPD research streams (Brown and Eisenhardt 1995) are used for a further review: rational planning, communication web, and disciplined problem solving. The *rational plan* perspective emphasises that successful product development is the result of (a) careful planning of a superior product for an attractive market and (b) the execution of that plan by a competent and well-coordinated cross-functional team that operates with (c) the involvement of top management. The rational plan research focuses on business performance and financial performance of the product. Seminal studies include the work by Myers and Marquis (1969) and SAPPHO studies (Rothwell et al. 1974). In recent years, rational planning is still an important research stream, for example, Calantone et al. (2003) study the impact of firm's

innovativeness, market orientation and top management risk taking on corporate strategic planning;

A second stream of NPD research centres on communication. This research stream has evolved from the pioneering work of Allen (1971, 1977). The underlying premise is that communication among project team members and with outsiders stimulates the performance of development teams. Thus, the better those members are connected with each other and with key outsiders, the more successful the development process will be (Katz and Tushman 1981; von Hippel 1986; Ancona and Caldwell 1990, 1992). For example, Allen (1971, 1977) and Katz and Tushman (1981) study the technology gatekeeper in NPD and stress the frequent external communication execrates successful NPD. Katz (1982) study the curvilinear relationship with group longevity, and found NPD success is mediated by external communication. Ancona and Caldwell (1990, 1992) conclude that NPD success requires external communication combining ambassadorial and task coordination; and internal communication as defined goals, workable plans and prioritised work. Dougherty (1992), by investigating 40 NPD projects, conclude that interactive and iterative communication, concrete experiences and violating organisational routines help NPD success. In recent years, under the stream of *the communication web*, the use and the sources (both internal and external) of information and knowledge towards NPD success are highlighted (e.g. Powell et al. 1996; Kodama 2006).

A third stream of research is termed the *disciplined problem-solving* perspective. This stream evolved from studies of Japanese product development practices in the mid-1980s (e.g. Imai et al. 1985; Quinn 1985). The issues for disciplined problem-solving mainly cover uncertainty, speed, flexibility, quality, productivity. For example, in studying NPD projects, Moenaert and Souder (1990) highlight the importance of information exchange as a positive function of the reduced uncertainty between R&D and marketing personnel. In studying speed and flexibility, Imai et al (1985) and Takeuchi and Noanka (1986) emphasis the internal team communication and multilevel learning. Womack et al. (1990) conclude that cross-functional communication contributes to quality, speed, and productivity in NPD. Macher and

Mowery (2009) study dynamic capabilities and emphasis the impact of inter-firm communication onto NPD cycle time. This perspective highlights that successful NPD involves relatively autonomous problem solving, such as uncertainty and time reduction, by cross functional teams, both internal and external with high communication and the organisation of work according to the demands of the development task.

Synthesis

Studies on NPD are often found to be inter-related. The NPD literature is further reviewed from an integrated perspective. To examine the links, this study employed the template of three main streams suggested by Brown and Eisenhardt (1995). Related studies between 1969 and 2009 were iteratively cross checked. The *rational plan* perspective is primarily exploratory and atheoretical and, thus, helps to broadly define the relevant factors for product-development studies (Myers and Marquis 1969; Calantone et al. 2003). The *communication web* stream complements this atheoretical view by replying on information processing and resource dependence theoretical perspectives in the context of traditional research studies (Thomas Allen 1971; Kodama 2006). The *disciplined problem-solving* stream takes the theoretical perspective of information processing one step further to problem-solving strategies (uncertainty and time reduction is highlighted), using a progression from inductive to deductive research and an emphasis on global industry studies (Imai et al. 1985; Macher and Mowery 2009).

Overall, these three streams capture the cumulative patterns of NPD research; that is, the NPD success comes from the careful NPD planning and disciplined problem solving by cross-functional teams with internal and external communication and effective top management involvement. More specifically, this study's interests lie in that companies require careful NPD planning, well communication web through multilevel learning and knowledge creation to solve problem, and thus to reach NPD success. Table 2.4 summarises these three main streams of research within the NPD literature:

	Rational Planning	Communication Web	Disciplined Problem solving
Description	Rational planning studies the management of the development of new products within organisations.	The communication web studies the use of information and sources of information by product development teams.	Disciplined problem solving focuses (e.g. uncertainty/time reduction) on how problems encountered during the NPD process were overcome.
Focus of the research	The rational plan research focuses on (1) careful NPD planning, (2) well-coordinated cross-functional team, and (3) top management involvement that contribute to business and financial performance.	The communication web looks at the effects of both internal and external communication on project performance by using information and knowledge from various sources.	The third stream involves problem solving by (1) cross-functional teams with (2) high communication and (3) the organisation of work with senior management involvement.
Seminal/important research and studies	Myers and Marquis (1969) and SAPPHO studies (Rothwell et al., 1974); Kleinschmidt et al. (1995); Calantone et al. (2003);	Thomas Allen's (1971, 1977); Von Hippel (1986);Dougherty (1992); Powell et al. (1996); Kodama (2006);	Imai et al. (1985); Moenaert and Souder (1990); Macher and Mowery (2009).

Table 2.4 (Source: Author)

2.4 IMPLICATIONS TO THIS STUDY

Five typologies provide guidance for the comprehension on the new product developing process. Nevertheless, five NPD models seem insufficient to comprehend the rich and complex body of the NPD literature. Six NPD research themes (strategy, company characteristics, management, process, people and information) guided a more systematic and through review in the massive NPD literature. Guided by different research themes, this study concludes that the literature on the 'NPD process' theme highlights the importance of study in uncertainty reduction and speed-to-market in which information is related; the studies on the theme of 'people' stressed the transition from cross-functional

coordination to innovation network collaboration; and the studies on the theme of 'information' infused the development of knowledge creation within which inter-firm learning is highlighted.

Three research streams (rational planning, communication web and disciplined problem solving) further helps for an integrated review. From the research stream of 'problem solving', NPD is viewed as a process of solving problems such as uncertainty and time reduction which is of interest of this study (Moenaert and Souder 1990; Appleyard 2003). It is suggested that common problems that occur within the product development process revolve around communications between different departments (Lievens and Moenaert 2000; Kodama 2001; Frahm et al. 2007). This problem specifically is with regard to the marketing/R&D interface (Moenaert and Souder 1994; Atuahene-Gima et al. 2000; Moorman and Rindfleisch 2001; Lu et al. 2004). From the 'communication web' research stream, studies on using internal and external information and knowledge from various sources are of interest in this study. The cross-functional teams approach aims to have a dedicated project team representing people from a variety of functions. In particular, it places emphasis on the use of project management and interdisciplinary teams. The interdisciplinary factor in helping NPD success leads to a more recent research thread – the network models.

Most recent thinking on the subject suggests new NPD models from the network perspectives. The literature review has revealed that, in recent years, the topic of NPD network has drawn scholars' research interests (Powell et al. 1996; Pyka 2002; Ritter and Gemunden 2004; Rulke and Galaskiewicz 2000; Akgun, Byrne, Keskin, Lynn, and Imamoglu 2005; Kodama 2006; Calia, Guerrini, and Moura 2007; Story, Hart and O'Malley 2009). Organisations collaborate within their own industries, as well as across sectors, for both strategic and social purposes (Eisenhardt and Schoonhoven 1996). Such partnerships represent the 'plumbing' of the market, and the strategic benefits of location in dense alliance networks have been well documented (Owen-Smith and Powell 2004). Powell et al. (1996) characterise such diverse industry networks in biotechnology as the 'locus of innovation', emphasising

the positive benefits of increased rates of learning and access to knowledge for NPD success. There is substantial evidence to suggest the external linkages can facilitate additional knowledge flows into the organisation, thereby enhancing the product development process (Andersson and Dahlqvist 2001; Appleyard 2003; Brown and Duguil 2002; Moorman 1995; Dyer and Nobeoka 2000; Cooper 2006). These models suggest that NPD should be viewed as a knowledge-accumulation process that requires inputs from a wide variety of sources. In studying innovation networks, knowledge dissemination, knowledge creation and learning are highlighted (Kodama 2006; Emden, Calantone and Droge 2006; Booz Allen and Hamilton 2004; Rittern and Gemunden 2003; Hellstrom and Malmquist 2000). For example, Powell, Koput and Smith-Doerr (1996) argue that when the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the NPD success derived from the firm-level of network learning. Miettinen et al. (2008) study the learning and network collaboration in NPD and conclude in collaborative NPD, network collaboration, new knowledge acquisition and learning evolve simultaneously and interactively. Hallikas et al. (2009) assert that NPD is the most knowledge intensive and complex processes in organisations and stressed that firms learning capabilities play a crucial role in NPD success. Finally, the review of the NPD literature provides an up to date understanding on the research topic. The literature review of NPD unfolds a need for further review in the literature of business relationships and firm's learning.

2.5 CONCLUSION

The different perspectives on new product development have produced a wealth of literature on the subject. A product can be viewed from three levels: core benefit or service, physical attributes and subject satisfactions, and the augmented or extended product. A new product is perceived by relative term 'newness'. That said, a new product is relative to what preceded the product, such as new to the company or new to the market. It is also suggested that the higher the newness involved in a new product, the higher the uncertainty and risk is.

The subject of NPD has attracted the attention of many scholars and practioners alike, interested often in uncovering the secrets of successful product development. Numerous studies and research projects have been undertaken in companies across many sectors and industries (e.g. Dougherty 1990; Cozijnsen et al 2000; Cottan et al 2001; Cooper et al. 2004; Deschamps 2005). As a result, research on new product development is varied and tangled. In reviewing such a complex and rich literature body, this study employed different templates to study NPD from various perspectives.

Five typologies develop the basic understanding of NPD from the perspectives of department, activity, decision, conversion process, and response behaviour. The review into six research themes contributes a thorough comprehension of NPD studies from the topics of strategy, company characteristics, management, process, people, and information. It suggests that NPD must be guided by corporate goals with decentralised and flexible structure in which collaboration, integration, and top management involvement contributes to the NPD success. This review also indicates that uncertainty reduction and NPD cycle time are tightly related to the NPD process in which the importance of cross-functional coordination, network collaboration together with the sources and usage of information and knowledge are highlighted. Finally, the studies in three NPD streams contribute to an integrated review into NPD literature, and concluded that studies from the rational plan view are primarily exploratory and help to define the relevant factors for NPD studies. The communication web stream complements this view by emphasising information processing and resource dependence. The disciplined problem-solving stream takes one step further to problem-solving strategies from information processing and resource dependence to internal and external communication. The review uncovers highly inter-related NPD studies and reveals two more recent and important topics – business relationships and learning. The study of network in NPD concerning the topics of knowledge-accumulation and inter-firm learning is at the heart of this study and will be further discussed in the following chapters.

Finally, for this study, five NPD models contribute to basic understanding of NPD in which developing process is highlighted. Six research themes guide a more thorough review on various NPD research topics. The review uncovered the empirical evolution from the cross-functional coordination to business network collaboration (the people theme) through knowledge creation (the information theme) for NPD uncertainty reduction and speed-to-market (the process theme). Three research streams provided an integrated review. The 'problem solving stream' highlights the importance of information exchange that helps to solve problems such as uncertainty/time reduction in NPD. The 'communication web' stresses using internal and external knowledge. The NPD literature review is important but insufficient for the research topic. A further literature review on business relationships and firm's learning is required. Figure 2.5 illustrates the implications to this study, drawn from the present NPD literature review.

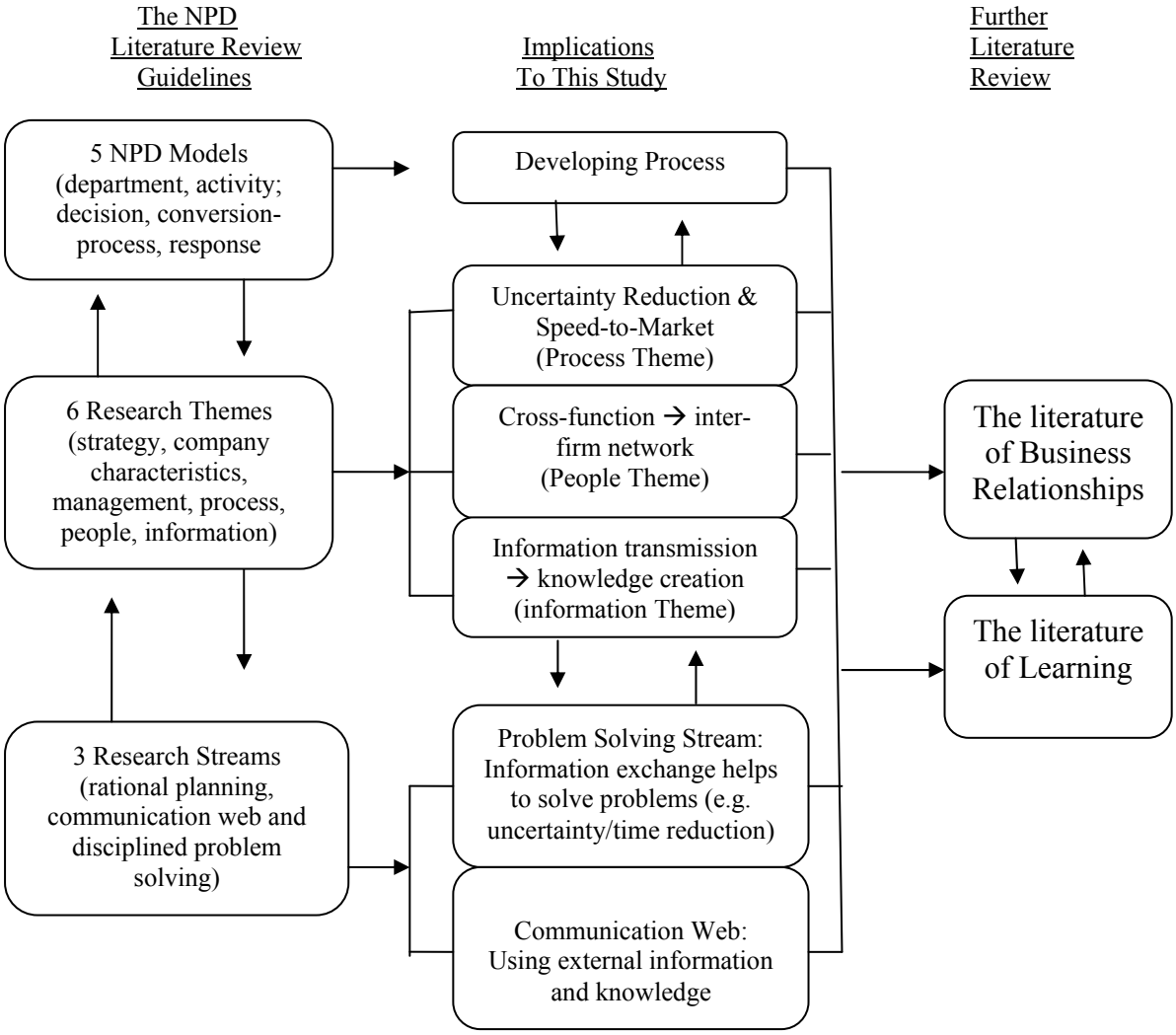


Figure 2.5 Implications from the NPD literature

CHAPTER 3

BUSINESS RELATIONSHIPS

CHAPTER THREE

3.0 Introduction

3.1 Inter-firm Relationships

Inter-firm Relationships and NPD

3.2 Embeddedness

Embeddedness and NPD

3.3 Business Networks

Business Networks and NPD

3.4 Conclusion

3.0 INTRODUCTION

This chapter aims to review the literature of business relationships concerning inter-firm relationship, embeddedness and business networks as well as their impacts upon NPD. It first reviews the literature in regard to inter-firm relationships before the studies into the embeddedness context. The literature of embeddedness helps to construct a better comprehension between inter-firm relationships and business networks. This chapter concludes by emphasising the importance of business relationships, embeddedness and networks in NPD, specifically on the knowledge transfer and creation which lead to the importance of the studies of inter-firm learning in NPD networks.

3.1 INTER-FIRM RELATIONSHIPS

What are 'inter-firm relationships'? Inter-firm relationships can be viewed as a process where two firms form strong and extensive social, economic, service and technical ties over time, with the aim of lowering total costs and/or increasing value, thereby achieving mutual benefit (Ritter et al., 2004; Anderson and Narus, 1991; Ford and Håkansson 2006). It is claimed that a company's inter-firm relationships 'are one of the most valuable resources that a company possesses' (Håkansson, 1987). In recent years, the literature on this aspect has contributed to the understanding between firms in business markets, within which interaction and interdependency are emphasised (e.g., Anderson and Narus, 1990; Anderson, Håkansson, and Johanson, 1994; Bonner and Walker, 2004). The Industrial Marketing and Purchasing Group (IMP), formed in 1976, has developed and carried out many research projects into the nature of the relationships between companies operating in complex business markets. From the paradigm of previous research tradition of discrete transaction decisions, they contributed to a new paradigm facilitated by the *Interaction Approach* (Håkansson, 1982; Turnbull, Ford, and Cunningham, 1996). That said, inter-firm relationships have value for their participants beyond the immediate transactions that take place within them. The interaction approach sees business markets as arenas within which buying and selling

companies interact with each other, which takes place within the context of a relationship between the companies. Studies show that many managers, in particular technical managers of various kinds, are involved in relationship interaction (Håkansson and Johanson, 2001). It is through the interaction, firms are able to demonstrate their willingness and ability to do what they intend to, which leads to their new ability to cope with changes (Håkansson and Ford 2002).

The value of the interaction approach is also resonated in other fields of studies. One of the most prominent areas is in the field of industry competitiveness originally stimulated by the contribution of Michael Porter (1981) and Peters and Waterman (1982) who posited that competition could be viewed as an interaction based on firms' co-existence, cooperation, collusion, or even conflict. In studying the evolution of Japan's corporate, Imai (2003) also found that, through interaction, companies receive and create knowledge in their inter-firm relationships. The notion that inter-firm relationships accommodate information transfer and knowledge creation is highlighted. Powell et al. (1996, 1998) echoed these themes by contending that firms' competitiveness can be re-shaped by the interaction approach and argued that as the structure of an industry shaped by inter-firm relationships, the nature of competition is altered. First, interaction accommodates inter-firm cooperation, accelerating the rate of technological innovation**.** Powell et al. (1996) demonstrated a ladder effect, in which firms with experienced partners competed more effectively. Furthermore, reliance on inter-firm relationships has potentially transformative effects on all participants. Through the interaction, knowledge is often generated. The presence of dense collaborative ties between firms may even alter the nature of competitiveness. Finally, inter-firm relationships may themselves become another dimension of competition, and a source of competitive advantage. The factor of interaction not only reshapes the nature of competition but also leads to another important phenomenon in business relationship – interdependency.

In recent years, the focus of the business relationship studies has been moved from the interaction approach to inter-firm's *interdependency*. Håkansson (2006), in studying inter-firm relationships, highlighted that technical interdependencies and

commercial interdependency are two critical driving factors in inter-firm relationships. Technical interdependencies come from companies' increased specialisation that has successively increased the sharing of technologies between firms. The specialisation makes companies more interdependent as they rely on others for related knowledge and resources that do not exist in the company. Commercial interdependencies are not only created over time due to thousands of small and large adaptations but can also be created through specific actions such as outsourcing, joint ventures, strategic alliances, supply chain alliances, and the use of specialists in combining others. Today, the need of interdependency, both technical and commercial, contributes to the fact that inter-firm relationships become an inevitable outcome form the nature of business (Ford et al 2006). This has increased the interdependence between companies that are specialised to solve fewer, but more complex problems for each other. These problems require more complex offerings and the activities of the companies involved have to be ever more closely linked within relationships. The growing interdependence between companies has been facilitated by the improvement in their ability to communicate with each other (Håkansson 2006; Ford et al. 2006).

Inter-firm Relationships and NPD

In studying inter-firm relationships, *relationship portfolio* is used to describe the range of relationships a firm participates in and are important to NPD. Ritter et al. (2004), in considering NPD, divided the business portfolio into relationships with *customers, suppliers, competitors and complementors.* Developing good working relationships with *customers* is a means by which a firm understands and serves customers' needs and co-develops new products and services. Relationships with *suppliers* of strategically valuable products and services can be an important and durable source of competitive advantage and, more importantly, one that is hard for others to imitate or steal (Dyer and Singh, 1998). Cooperative relationships among *competitors* may be developed for various purposes, beyond the typical collusion to control and subvert competition, such as competitors collaborating to develop product and technology standards. Finally, firms develop relationships with many

other types of firms whose outputs or functions increase the value of their own outputs. One example is joint marketing schemes. Another example is the relationships with government agencies that can be important in entering new markets or pressing for better access to new markets, obtaining financial resources, or in keeping informed about legislative developments (Ritter et al. 2004). Among business studies on relationship portfolios in the NPD field, customer relationships appear to be of the utmost interest. For example, in studying NPD, Von Hippel (2001-2003) highlighted the importance of the relationships with lead-users which turn to be one of the most important sources for product development. Baxter and Matear (2004) emphasised the value in business-to-business buyer-seller relationships, and found out that the access, through customer relationships, to intangible assets (such as intellectual property and brands) in the customer's organisations was extremely valuable, and the help they get from customers towards future product development was also a tremendous benefit. The relationship literature also suggests that involving customers that have had close and embedded relationships with a firm's new product organisation, such as a firm's lead users (Von Hippel, 2001-2003), and customers that have been involved in past collaborative activities, should develop superior products.

In sum, 'inter-firm relationships' have received a great deal of attention from both academics and practitioners. Among those, the IMP group has contributed enormously to studies in inter-firm relationships. The existence of inter-firm relationships between companies has been observed in a range of studies over the past years. The inter-firm relationships can be viewed as the outcome of interactions between the business units. Inter-firm relationships enable companies to cope with their increasing technological and commercial interdependencies. A firm's business relationship portfolio describes the range of firm's participation and provides a signal of the quality of the firm's activities and products. In considering NPD, business relationship portfolio highlights the importance of the relationships with *customers, suppliers, competitors and complementors.*

3.2 EMBEDDEDNESS

Relational interaction and interdependency are frequently influenced by many other relationships in which the interacting partners are involved. A customer's customer, a supplier's suppliers, competing and complementary suppliers, competitors, joint ventures, consultant and intermediary firms can all have an influence on the interaction and interdependency in inter-firm relationships. Developments in business practice have suggested that to understand these business relationships, greater attention must be directed to the *embedded context* (Granovetter 1985; Baum and Dutton 1996; Bonner et la. 2004; Andersson et al. 2007; Krippner et al., 2004; White et al. 2004; Uzzi and Lancaster 2004). The embeddedness perspective highlights the role of a firm's social and economic position to explain business actions such as alliance formations and inter-firm exchange (Gulati and Gargiulo 1999; Uzzi and Lancaster 2001). It is argued that although strategic alliances are essentially dyadic exchanges, key precursors, processes, and outcomes associated with them can be defined and shaped by the social structures of ties within which most firms are embedded (Granovetter 1985). In understanding the evaluation from inter-firm relationships to business networks, this section reviews the related literature on embeddedness.

Embeddedness (Granovetter, 1985, 1992) is one of the most commonly cited ideas in understanding the business relationship and networks. Granovetter (1992, p33) defined embeddedness as:

> *"Embeddedness refers to the fact that economic action and outcomes, like all social action and outcomes, are affected by actors' dyadic (pair-wise) relations and by the structure of the overall network of relations. As shorthand, I will refer to these as the relational and the structural aspects of embeddedness."*

He further specified (p35) his understanding of the embeddedness from information spreading and cohesive power perspectives which lead to extended insights on networking:

> *"To the extent that a dyad's mutual contacts are connected to one another, there is more efficient information spread about what members of the pair are doing, and thus better ability to shape behaviour. Such cohesive groups are better not only at spreading information, but also at generating normative, symbolic, and cultural structures that affect our behaviour.*

Several researchers have studied the dynamics of structural embeddedness and its evolution towards business networks. For example, cohesiveness in relational embeddedness raised many scholars' attention and the embedded ties were studied from various perspectives. Embedded ties have been viewed as relationships in which they had a social closeness to and familiarity with the allied actors and can be categorised by the degree of cohesiveness to the relationships (Uzzi and Lancaster 2003). For example, strong ties are referred to cohesive and frequent business relationships; weak ties are distant and infrequent business relationships; and *arm's-length ties* were regarded as relationships that lacked social closeness to the allied actors. White et al. (2004), in studying the network evolution from tie formations to embedded dynamics, highlight the dynamic interaction between intra- and inter- firm relationships and the dynamics of micro-macro linkages between local behaviour in networks and in global network attributes. They stressed an interlocking concept in embedded business relationships and claimed that organisations gain the benefits of dynamic interaction through overlaps and cohesion. In studying embeddedness, direct and indirect ties have also been stressed (e.g. Berg, Duncan and Friedman 1982; Ahuja 2000). A direct tie connects a business relationship between two companies (company A and company B); and an indirect tie connects the business relationship between company A and company C embedded through both connections with company B. In studying direct and indirect ties, the understanding of relational embeddedness and structural embeddedness is of value (Granovetter 1992; Gulati 1998). The relational embeddedness (or cohesion networks) highlights

the role of direct cohesive ties; and the structural embeddedness (or positional networks) goes beyond the immediate ties (or direct ties) of firms. Ahuja (2000) has studied the relational embeddedness from the perspective of direct and indirect ties and highlighted that a firm's direct ties potentially provide both resource-sharing and knowledge spillover benefits; and indirect ties do not entail formal resource-sharing benefits but can provide access to knowledge spillovers In the discipline of embedded relations, the exchange-based paradigm has been distinguished between *vertical and horizontal integration* (Stuart 1998; Gulati and Lawrence 1999)**.** Studies that separate horizontal alliances (e.g. among competitors) from vertical alliances (e.g. among channel members) have helped to gain better understanding in relational embeddedness (e.g. Robertson and Gatignon 1998; Rindfleisch and Moorman 1999). Galaskiewicz (1985) has posited that the nature of the relationship between these two was different in that competitors share 'horizontal interdependency by competing for similar resources and producing similar goods; suppliers and customers, on the other hand, share 'symbiotic vertical interdependence' by rendering services to each other in a complementary manner.

Embeddedness and NPD

Scholars have studied the embeddedness in NPD from various perspectives. For instance, Kaufman et al. (2006) studied the role of relational embeddedness in retail buyer's section of new products and have concluded that firm's relational embeddedness has a greater influence on new product acceptance. Ahuja (2000) has studied embedded collaboration's cohesiveness from the context of direct and indirect ties and found that both direct and indirect ties have a positive impact on products' innovation, and clarified a myth that direct ties had more positive impacts than indirect ones. Uzzi and Lancaster (2004) used embeddedness to studying the corporate law market, and concluded that embedded ties created expectations of trust and reciprocity that reduced transaction costs and prompted the sharing the benefits to mutual advantage.

The embeddedness consideration appears to be important, and has drawn many NPD researchers' interests in various arenas, especially in information sharing and knowledge transferring. For example, Rindfleisch and Moorman (2001) examine the acquisition and utilisation of information in new product alliances and conclude that relational embeddedness enhances both the acquisition and utilisation of information in alliances. Hansen (1999) separated weak ties from strong ties and studied the role of weak ties in sharing knowledge in NPD. Hansen found that neither weak nor strong ties leads to efficient knowledge sharing, but that the complexity of the knowledge to be transferred impacted on the NPD completion time. Rindfleisch and Moorman (1999, 2001), have highlighted the importance of differentiating vertical from horizontal alliances in studying NPD, and utilised the vertical and horizontal alliances as the target to examine the acquisition and utilisation of information in embedded relationships. In studying NPD in B2B sectors, relational exchange researchers claim that in developing new products, companies involve close-tie partners to exchange complex information and knowledge (Håkansson 1989; Rindfleisch and Moorman 2001; Sivadas and Dwyer 2000). Nevertheless, Innovation researchers have cautioned that too close to their existing customers may be unable to incorporate a diversity of knowledge sources in NPD and thus unable to generate substantial product innovations (Bonner and Walker 2004). Bonner and Walker (2004) contributed to the literature by empirically testing relational and innovation theories in NPD projects and emphasised the importance of structural embeddedness and knowledge heterogeneity in selecting influential customers in NPD.

In sum, the understanding of embeddedness helps the studies of business relationships and business networks. Embeddedness is affected by actors' dyadic relations and by the structure of the overall network of relations. Embeddedness has been studied from the perspective of cohesiveness and from the context of arm's-length ties, weak/strong ties, and direct/indirect ties; and further studies from tie formation to network dynamics that vertical and horizontal integration is incumbent. In studying new product development, the embeddedness consideration appears to be important, especially from the perspectives of information/knowledge transfer.

3.3 BUSINESS NETWORKS

In recent years, many scholars have called for a transformation of a 'new' market paradigm where managers' roles will increasingly shift away from the dyadic paradigm towards to a network paradigm, that is, the age of business networks (e.g. Miles et al., 2006; Sammarra and biggiero 2008). What is a *business network*? Some scholars have claimed that the network surrounding a company is difficult to define and delimit (Ford et al, 2002). It has no objective boundaries and its contents will be affected by both the purpose of the analysis and its starting point. Emerson (1981) views a business network as a set of two or more connected business relationships, in which each exchange relation is between business firms that are conceptualised as collective actors, within which the structure of relational embeddedness accommodates the formation of the business network. White et al., (2004) see a business network as a formal construction which contains a set of relational nodes and one or more sets of embedded ties. Perez and Sanchez (2002) define 'business networks' as a firm's set of embedded relationships with other organisations', while a relationship or linkage is defined as 'inter-organisational interaction processes and bonds with economic targets, directed to a sequence of exchanges (Germunden 1990). Imai (2003) described 'business networks' as a certain form of multi-faceted inter-organisational relationship.

Håkansson and Ford (2002) from the IMP group see a business network as a structure where a number of nodes are related to each other by specific threads. That said, a complex business market can be seen as a business network where the nodes are business units – manufacturing and service companies and the relationships between them are the threads. Both the threads and the nodes are 'heavy' with resources, knowledge and understanding in many different forms (Håkansson and Ford 2002). The heaviness is the result of complex interactions, adaptations and investments within and between the companies over time. It is not a world of individual and isolated transactions between companies. Instead, each node or business unit, with its unique technical and human resources is bound together with

many others in a variety of different ways through its relationships. In other words, a business network contains the threads and the nodes in the business context; and both threads and nodes have their own particular content bounding together through its embedded relationships. Business networks have been a part of our social, business and technological environment for centuries, researchers have only recently uncovered many of their attributes.

Various studies on business networks are generated from different perspectives towards the characteristics of business networks. By studying the growth of interorganisational collaboration in the life sciences, Powell et al. (2005) studied business networks from a multiconnectivity perspective, and highlighted that a business network structure in which multiconnectivity expands as the networked participants' increases. They also found that those organisations with diverse portfolios of well-connected collaborators are the most cohesive and central positioned, and have the largest hand in shaping the evolution of the field. By studying industrial systems, Axelsson (1993) identified three network attributes: the unboundedness, the non-transparency, and the dynamics and effectiveness. The point of *unboundedness* says that extension rather than limitation is a basic attribute of networks. The argument of *non-transparency* contents that business relationships are subjective, ambiguous and fluid and cannot be fully understood by outside observers. Hence, business networks are basically invisible and incomprehensible to outsiders. The *dynamics and effectiveness* aspects postulate the 'continuations' and 'changing' elements in business networks, thus, how to react to the inside changes and outside influences is of importance. For example, the usage of strong relationship ties to take advantage of the potential of joint collaboration, and weak ties to monitor other changes.

In a 2002 IMP conference, Ford et al posited three common myths in business networks. Those were interaction, interdependence and incompleteness. These three myths provide valuable insights in understanding business networks. The *interaction myth* depicts the problem-solution orientation in that business networks consist of a large number of active and heterogeneous firms each interacting with others and

seeking solutions to their different problems (Håkansson 1987; Axellson and Easton 1992). Moreover, these firms are *inter-dependent* for sales, supplies, information, and technology development (Ford et al. 1998). The *incompleteness* describes the complementary nature of networks (Gulati et al, 1999; Brown et al., 1996). That said firms are dependent on the skills, resources of suppliers, customers, and even competitors to satisfy requirements that they often do not possess. Similar contention was presented by McEvily and Zaheer (1999) who viewed a firm's business network as an important source of *heterogeneity* in the acquisition of competitive capabilities, which emphasis the value of complementary in business network collaboration. Business networks have been studied from the perspective of the benefits to companies in which resource-based theory and knowledge based theory are highlighted (Porter 1996; Eisenhardt and Martin 2000; Rindfleisch and Moorman 2001; Uzzi and Lancaster 2003). For example, in a longitudinal study on business networks, Ahuja (2000) summarised two distinct business network benefits. First, business networking provides the benefit of resource sharing, allowing firms to combine knowledge, skills and physical assets. Second, collaborative linkages provide access to knowledge spillovers, serving as information conduits through which news of product development breakthroughs, new insights to problems, or failed approaches travels from one firm to another. The themes of resource-sharing and knowledge spillovers have drawn many scholars attention and contributed to the business networks studies, especially for new product development (e.g. Johnnson 2008; Tikkanen and Renko 2006; Teece et al. et al 1997; Cohen and Levinthal 1990; Zoll and Winter 2002; Nonaka and Toyama 2003).

Business Networks and NPD

A study of 650 industrial and 487 non-industrial participants in 339 projects conducted by EUREKA (1993), a pan-European framework for inter-firms' collaboration in business networks, reported that the top three driving forces for the industrial firms to join collaborative ventures were: access to complementary technical expertise (74%), cost- and risk-sharing (53%) and gaining experience of new markets (31%). It was also found (Eureka 1993) that firms collaborated in their

business networks mainly for speeding up product development, searching for new knowledge and ideas within the company's technology base, and reducing uncertainty.

Companies increasingly see alliances with other firms as a way to create successful new products as indicated by Biemans (1992) that NPD is increasingly the outcome of collaboration in business networks. New product developers seek access to complementary resources, improved competitiveness, and flexibility through business networks. Chakravorti (2004) posited that there are two types of economies in product development networks. First, new products that have large networks around them are often cheaper to use than products that have small networks around them. Second, a product's value to each user increases as the size of the network grows. Hellstrom and Malmquist (2000) highlight the concept of 'collective invention' (Allen 1983) and suggest an 'industrial network' approach to product development. This approach emphasises the underlying technological interdependencies of product development networks, and links technological development to changes in the network governance structure and to resource structures in companies (Håkansson and Snehota, 1995).

Companies increasingly see alliances with other firms directly or indirectly as a new way to successfully create new products within which information transferring, knowledge creation, and inter-firm learning are emphasised as key driving forces in forming firms' business networks. For instance, Rindfleisch and Moorman (2001) defined *new product alliances* as formalised collaborative arrangements among two or more organisations to jointly acquire and utilise information and know-how related to the research and development of new product (or process) innovations. Firms may benefit from having a network of knowledgeable contacts that provide a reliable source of information about options for enhancing competitive capabilities. Burt (1992) argued that the information benefit from business networks are 'receiving a valuable piece of information and knowing how to use it'; thus, it is of value for NPD. Similarly, Gulati (1999) viewed business network resources as

representing the informational advantages associated with a firm's network, and highlighted exchange, sharing, and product co-development.

In NPD, business networks not only serve the role as an information channel, but a facilitator of new knowledge generation as well. In examining factors influencing new product success in internal and external based processes, Sivadas and Dwyer (2000) pointed out that parties involved in a new product development project, be it conducted internally or externally, must share, digest and act on information; more importantly, it is this transfer and recombination of information that allows for the creation of new knowledge. As product development processes become more complex, knowledge tended to be scattered among a large number of firms (Baldwin and Clark, 2000), and firms often needed to collaborate when they sought to harness this knowledge. The role of knowledge is at the heart of many NPD network studies. For example, Hamaakorpi and Melkas (2005) have studied knowledge creation in NPD networks and explicit and tacit knowledge is taken into account within the knowledge management systems. Johnston and Paladino (2007) investigated 313 Australian MNCs and highlighted a significant association between the knowledge management and the involvement in NPD networks. In studying the heterogeneity and specificity of inter-firm knowledge flows in NPD networks, Sammarra and Biggiero (2008) concluded that in most collaborative relationships in business networks, network partners exchange technological knowledge together with market and managerial knowledge. Sammarra and Biggiero emphasised the complex nature of the NPD process which requires access to and recombination of diverse knowledge.

In studying contemporary new product development, the studies of knowledge transfer and creation leads to the studies of inter-firm learning in NPD networks. Powell et al., (1996) studied the biotechnology industry in 1990s, and documented a network form of organisation with a particular competence for NPD. Powell et al (1996) argued that when the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the locus of NPD will be found in inter-firm learning in business networks. This contention has been

supported by many other scholars (von Hippel 2007; Johnson 2008; Mohannak 2007; Ingram and Roberts 2000). For instance, Von Hippel (2007) reinforced the importance of NPD network learning by emphasising the benefits of using NPD networks by and for users. The competition and inter-firm learning in product development networks also drew researchers' attention. For example, Ingram and Roberts (2000) found that firms have the most to learn from their closest competitors. Dyer and Nobeoka (2000), by studying Toyota's production networks, provided further insight as to how network structures promoted inter-firm learning with their case study of highly successful NPD. Dyer and Nobeoka believe that if the business network can create a strong identity and sound collaboration rules, then it will be superior to a firm in creating and recombining knowledge due to the diversity of knowledge that resides within firm's business networks. They have urged that the notion of a dynamic inter-firm learning capability that creates competitive advantage needs to be extended beyond firm boundaries. In studying business networks and product development, many observers of today's business scene agree that the most underutilised resource among firms in advanced economies is knowledge, and that knowledge generation and the learning process needs to be opened up considerably (Miles, Miles, and Snow, 2006). Studies on business network contribute to the understanding of 'what' makes new product success.

In sum, new product success relies heavily on the collaboration in business networks. Today, this business phenomenon has become even more prominent in that collaboration in NPD networks facilitates access to complementary resources and improves firm's competitiveness. NPD needs information and knowledge. Business networks not only provide product developers the conduits for information transferring but also accommodate knowledge creation for better NPD, in which the access to and recombination of diverse knowledge are highlighted. The notion of information transfer and knowledge creation in NPD networks pinpoints the importance of inter-firm learning in business networks for NPD success.

3.4 CONCLUSION

Rapid changes in technology, the competitive environment, and uncertainty on customers and resources, are prompting many firms to seek continuing collaborative relationships with other firms. Inter-firm relationships are formed; and interaction and interdependency are emphasised. Relationship portfolios help to understand the range of relationship a firm participates, in that the relationships with customers, suppliers, competitors and complementors as well as the impacts on NPD are discussed. Embeddedness, with the concepts of embedded ties, vertical and horizontal integration, contributes to the understanding from the dyadic relationship to a network system. The embeddedness framework model examines how the quality of relations and the network positions affects the network members' access to information and governance abilities. Business networks are complex and difficult to define. It derives from a set of embedded relationships with other organisations in which nodes and threads with dynamic interactions among firms are emphasised. Studies in business networks highlighted the diversified access of the transfer from those that have the capabilities and experiences to those which seek to use them.

A long stream of research suggests that interdependency is the most common explanation for the formation of inter-firm relationships and networks by considerations of timely resource procurement and uncertainty reduction (e.g. Håkansson 2006; Ford et al 2006). Scholars (e.g. IMP group) contribute to the understanding of interdependency in inter-firm relationships and business networks which can also be seen as a response to the contemporary challenges in business market in which information and knowledge transfer is highlighted. The existing inter-firm relationships and network research suggests that timely, relevant information and knowledge on capabilities and experiences is the key to NPD success. It is pinpointed that new product alliances is an important research issue that represents the forefront of 'the changing dynamics of competition and cooperation (e.g. Powell et al 1996; Owen-Smith et al. 2004; Ahuja 2000). The nature of the network surrounding a company, determines its ability to control information flows, knowledge flows and financial flows. The drive to turn knowledge and other

underutilised resources into NPD is what pushes managers to experiment with new ways of reconfiguring strategies, structures, and processes. This driving force largely relies on an important organisational behaviour called 'inter-firm learning'.

The literature claims that inter-firm relationships, embeddedness and networks are important in managing organisational change. To sustain a competitive advantage, firms must constantly seek out new opportunities for upgrading and renewing their capabilities. Consequently, firms benefit from having a network of knowledgeable contacts that provide a reliable source of information about options for enhancing competitive capabilities and of resources to cope with fast moving changes. In other words, firms in business markets rely on collaborative relationships to access, survey, and exploit emerging technological and business opportunities. These attributes become prominent and important to NPD success. Indeed, the study on the inter-firm relationships and business networks is rather complex. Collaboration with business networked members is, nowadays, a compulsory activity for new product developers. Many scholars have emphasised that the study of business networks in new product development is of urgency, both theoretically and empirically (e.g. Powell, Koput and Smith-Doerr 1996). Today the tightly networked business markets set up a very challenging platform to NPD. Many observers of today's business world agree that for NPD in advanced economies, the most underutilised resource among firms is knowledge, and that the knowledge generation and learning process, which requires and efficiently utilises firms' capabilities, needs to be opened up considerably (e.g. Johnson 2008; Mohannak 2007; Ford and Håkansson 2006; Tikkanen and Renko 2006; Harmaakorpi and Melkas 2005; Owen-Smith and Powell 2004). Table 3.1 summarises the business relationships literature review on the topics of inter-firm relationships, embeddedness and business networks.

	Inter-firm relationships	**Embeddedness**	**Business Networks**
Description / Definition	A process where two firms form strong and extensive social economic, service and technical ties over time, with the aim of lowering total costs and/or increasing value, thereby achieving mutual benefit	Economic action and outcomes are affected by actors' dyadic relations and by the structure of the overall network of relations.	A structure where a number of nodes are related to each other by specific threads; both nodes and threads are 'heavy' with resources, knowledge and understanding in may different forms
Key Concepts	Interaction, Interdependency, Dyadic	The relational and the structural embeddedness, strong/weak ties, arm's-length ties, direct/indirect ties, vertical and horizontal integration,	A set of embedded relationships; nodes and threads; unboundedness, non-transparency, dynamics and effectiveness; interaction myth, inter-dependency, incompleteness; heterogeneity; knowledge transfer; inter-firm learning in business networks
Impacts on NPD	Relationship portfolio: customers, suppliers, competitors, and complementors.	Information acquisition and utilisation, structural embeddedness and knowledge heterogeneity.	Network collaboration to speed up NPD, searching for new knowledge and ideas and reducing uncertainty.
Seminal/important research and studies	IMP group (e.g. Håkansson, Anderson, Joanson, Ford (1976 - present); Ritter et al. (2004); Von Hippel (2001-2003); Ritter et al. (2004).	Granovetter (1985, 1992); Ahuja (2000) Uzzi and Lancaster (2001); Rindfleisch and Moorman (1999, 2001); Bonner and Walker (2004).	IMP group (e.g. Ford et al 2002; Håkansson et al. 2002); Powell et al. (1996; 2005); Imai (2003); Dyer and Nobeoka (2000); Johnston et al. (2007).

Table 3.1: the literature review on business relationships

CHAPTER 4

LEARNING

CHAPTER FOUR

4.0 Introduction

4.1 Firm's Learning

Definition

Process

4.2 Inter-firm Learning

Definition

Process

4.3 Learning in Business Networks

Network Context and Firm's Learning

Process

4.4 Emergent Themes and Theories

Knowledge and Information

Nature of Knowledge – Tacit and Explicit

Knowledge Transfer and Transformation

Exploitation and Exploration

Unlearning

Dialogue

Articulation

4.5 Implication and Conclusion

4.0 INTRODUCTION

This chapter aims to review the literature in the domain of learning in business markets. The literature into the topic of learning is vast. The guideline used for this chapter is twofold. First, this study concerns how learning takes place in the business markets; learning process is of the most interest. Second, the understanding of firm's learning helps the understanding of inter-firm learning, in turn, helps the understanding of business network learning. The chapter first reviews the literature in regard to firm's learning and its process, followed by the literature of inter-firm learning and its process, and finally the literature of business network learning and its process. Emerging from research evidence in chapter seven and eight, several important themes have been revealed in this study and require further review in the related literature. Section 4.4 further reviews the literature in regard to these emergent themes. This chapter concludes by summarising studies of the process from firm's learning to inter-firm and business network learning.

4.1 FIRM'S LEARNING

Definition

What is firm's learning? Cyert and March (1963) define firm's learning as a process by which firms collectively learn through interaction with their environment. Argyris and Schon (1978) viewed firm's learning as '*experience-based improvement in organisational task performance*' (p.323), and asserted that firm's learning occurs when learning agents respond to changes in the internal and external environments of the organisation. Daft and Weick (1984) defined firm's learning as the process by which knowledge about action-outcome relationships between a firm and its environment. DiBella et al. (1996) emphasis the experience factor in firm's learning and defined firm's learning as '*the capacity (or processes) within an organisation to maintain or improve performance based on experience'* (p.363). Holmqvist (2003) sees a firm's learning as '*the social production of organisational rules based on experience that leads to a changed organisational behaviour*' (p.98). Holmqvist sees

a firm's learning from four factors: (1) experiential improvement; (2) firm's interaction with the environment; (3) changes in firm's modelling of the environment; and (4) firm's action. Firm's learning is tightly linked with firm's experience in responding to the environmental change; and this linkage is important in studying firm's learning process.

Process

Cyert and March (1963) proposed a firm's learning process contains three important steps: to ask the right questions at the right time; to absorb the answers, share understanding of implications; and to act decisively. Cyert and March's (1963) learning process set up a fundamental framework in addressing learning taking place in a process of acquisition or recognition (ask right question), transmission or assimilation (share understanding), and application (act). This learning process has been well-accepted and well developed in later years (Daft and Weick 1984; Argyris and Schon 1978; Huber 1991; Sinkula 1994; Moorman 1996; Day 2002). For example, Daft and Weick (1984) proposed a three-stage model that constitutes a basic structure of a firm's learning process: scanning, interpretation, and learning. *Scanning* is the process of monitoring the environment and providing environmental data to managers. Thus, scanning is concerned with information collection. *Interpretation* is where information is given meaning; in other words, it is the process of translating events and developing shared understanding and conceptual schemes among members of upper management. *Learning* involves a new response or action based on the interpretation.

How information and knowledge is managed is the key to firm's learning. Huber (1991) depicted four firm's learning constructs as: *knowledge acquisition* (the process by which knowledge is obtained); *information distribution* (the process by which information from different sources is shared and thereby leads to new information or understanding); *information interpretation* (the process by which distributed information is given one or more commonly understood interpretations); and *organisational memory* (the means by which knowledge is stored for future use).

A firm's learning has also been seen as a market information process (Sinkula 1994; Slater and Naver 1995; Day 2002). For instance, Slater and Narver (1995) viewed a firm's learning as a three stage market information process that includes *information acquisition:* information obtain from direct experience, the experiences of others, or firm's memory; *information dissemination:* effective dissemination, or sharing, increases information value when each piece of information can be seen in its broader context by all organisational players who might use or be affected by it and who are able to ask feedback questions, amplifications, or modifications that provide new insights to the sender; and *shared interpretation*: claimed that for firm's learning to occur, there must be a consensus on the meaning of the information and its implications for the firm.

In studying market information process, Day (2002) postulated three groups of activities. *Sensing activities* include initiated or continued inquiry, open-minded inquiry, and widespread information distribution. *Sense-making activities* are mutually informed mental models and information utilisation. In investigating how firm's learning taking place, Marsh and Stock (2006) studied the influence of knowledge retention and interpretation activities on firm's ability to integrate knowledge in prior projects. Knowledge retention refers to firms' engagement in formal routines to store knowledge developed in prior product development projects. Knowledge interpretation is the process through which information is sorted, categorised, and given meaning (Daft and Weick 1984; Dougherty 1992). Knowledge integration concerns the application of knowledge in prior projects. Through the process, Marsh and Stock found that it enables exploitation of existing knowledge to solve the problems. Marsh and Stock claim that knowledge retention and interpretation activities impact on a firm's performance through the firm's ability to apply knowledge developed in prior projects. This study suggests a process of firm's learning and highlights the importance of learning from previous projects.

In sum, firm's learning concerns experience in dealing with the environmental change. Firm's learning has been viewed as a market information process. A process of acquisition or recognition (ask right question), transmission or

assimilation (share understanding), and application (act) sets up a fundamental framework in addressing firm's learning process (Cyert and March 1963), as well as in understanding inter-firm learning process.

4.2 INTER-FIRM LEARNING

Definition

Inter-firm learning can be viewed as a collective acquisition of knowledge and skills (Hamel 1991; Larsson et al. 1998; Halme 2001; Ingram 2002). Learning is more complicated when extended to an inter-firm setting. It is considered different from a firm's learning because it includes a learning synergy effect between firms that would not have occurred if there had not been any interaction (Larsson et al. 1998). In this sense, inter-firm learning occurs when one firm causes a change in the capacities of another, either through experience sharing, or by stimulation (Ingram 2002). Inter-firm learning is therefore a joint outcome of the interacting of firm's intent and abilities to be more or less transparent and receptive to its learning partners (Larsson et al 1998; Hamel 1991; Inkpen 1996). In this sense, knowledge transfer or knowledge creation cannot be 'the one firm' served by learning process but occur in an inter-firm arena.

Process

Many firms enter into inter-firm cooperation with specific learning objectives, within which 'borrowing' is one of the major objectives (Lyles and Salk 1996; Inkpen 1996). In studying organisations, March and Simon (1958) suggested that most innovations result from 'borrowing' rather than invention. This observation of 'borrowing' is supported by extensive studies on the outside sources of knowledge in inter-firm learning (e.g. von Hippel 1986; Cohen and Levinthal 1990; Powell et al. 1996). Among those, the *absorptive capacity* posited by Cohen and Levinthal (1990) is one of the well-cited theories. Absorptive capacity is labelled as '*the ability of a firm to recognize the value of new, external information, assimilate it and apply it to*

commercial ends' (Cohen and Levinthal 1990, p128). This definition succinctly captures the steps involved in the inter-firm learning process (to recognise, to assimilate, and to apply) and underlies a fundamental base in learning from outside the firm. Absorptive capacity conceptualised the essential role of the complementary of knowledge, with its communication system, especially in dealing with uncertainty and random information flows from individual to firm's levels. It is believed that effective communication interacts across companies that each possess diverse and different knowledge structures and this will augment the firm's capacity for making novel linkages and associations – innovating – beyond what any one company can achieve (Cohen and Levinthal 1990; Tsai 2001; Matusik and Heeley 2005). A firm needs the capability to exploit and utilise external knowledge. Transferring knowledge is a complex process, and it often requires time, effort and internal resources on the recipient's side to assimilate external knowledge. It is difficult to evaluate, absorb and utilise imported knowledge if a firm does not have an internal capacity to do so (Cohen and Levinthal 1990; Rosenberg 1988; Prahalad et al. 1986).

In understanding inter-firm learning, the knowledge creation model conceptualises a framework of how learning takes place from an individual to inter-firm and from a firm to inter-firm (Hedlund 1994; Nonaka 1994; Holmqvist 1999; Nonaka and Toyama 2003). Nonaka's (1994) SECI process is an early and frequent cited reference on the knowledge-creation model. The SECI process consists of four mechanisms of knowledge conversions from individual knowledge to inter-firm knowledge. These are labelled: Socialisation, Externalisation, Combination, and Internalisation, and have been studied from different perspectives over many years (e.g. Nonaka 1994; Nonaka and Takeuchi 1995; Ken et al. 1998; Fabio et al. 1999; Nonaka and Toyama 2002, 2003, 2005, 2006). The knowledge creation model explains the inter-firm learning process from the tacit and explicit knowledge perspectives:

Socialisation:

- From individual tacit knowledge to inter-firm tacit knowledge: individuals participating in inter-firm cooperation may come together and work closely

on a project, e.g. new product development, thereby having opportunities to create mutual tacit knowledge.

- From firm's tacit knowledge to inter-firm tacit knowledge: knowledge related to a firm's rules and routines may be tacitly transferred between members of different firm's actors without them being explicitly aware of it. By drawing on firm-specific routines in partner-interactions, these routines may become the routines of the interaction, too, resulting in a creation of a joint tacit and mutual knowledge

Externalisation:

- From individual tacit knowledge to inter-firm explicit knowledge: when cooperating with other firms, people will be forced to articulate what they individually take for granted given the diverse backgrounds of the different actors involved. The resulting outcome may be stored in the firm's artificial memory, such as jointly written standard operating procedures.
- From firm's tacit knowledge to inter-firm explicit knowledge: firms tend to act in a routine manner without being explicitly aware of doing so. Thus, knowledge is often 'hidden' that may be important for an affiliated partner to understand. This is the reason why individuals should take time to reflect on their taken-for-granted behaviour so that 'outsiders' are able to understand and share with them their knowledge. For instance, writing down how the firm behaves in specific situations, or by orally problematic routine behaviour, inter-firm knowledge may be codified and stored to the benefit of inter-firm learning.

Combination:

- From individual explicit knowledge to inter-firm explicit knowledge: by transferring technical knowledge of an explicit character held by single individual to the other members of a cooperated organisation, the joint organisational memory system, in the form of written documents, may be increased.

- From a firm's explicit knowledge to inter-firm explicit knowledge: in ordinary firm's life, people often act according to explicit rules and regulations that are written down and preserved in the organisation's artificial memory structure. When this explicit knowledge is presented to other partners, inter-firm knowledge may be formed by combining it with the partners' explicit knowledge.

Internalisation:

- From individual explicit knowledge to inter-firm tacit knowledge: explicit knowledge held by single individuals, for example, knowledge of a specific design variable of a product, may be transferred among the parties involved. If the explicit knowledge gains acceptance, it may become stored as 'routine-knowledge' of all the actors, tacit knowledge thus forms.
- From organisational explicit knowledge inter-firm tacit knowledge: knowledge derived from another firm's artificial memory bank and transmitted by individual may be written down and specified in a joint memory store. However, over time, and if people in the inter-firm cooperation find that knowledge important for working together, they will recall it only tacitly. The knowledge will be embedded in routine behaviour, which would add to the partner organisation's tacit inter-firm knowledge.

The knowledge-creating model conceptualises a dynamic learning as a dialectical process, in which various contradictions as synthesised through dynamic interactions among individuals, organisations, and inter-organisations. Figure 4.1 illustrates the model:

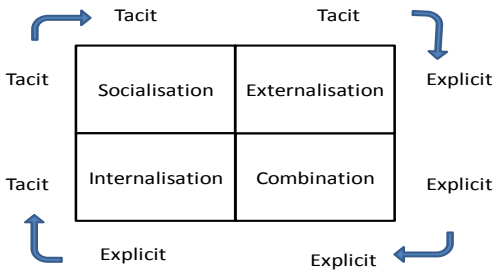


Figure 4.1: SECI Model (Source: Adapted from Nonaka and Takeuchi 1995)

Another well cited reference for the inter-firm learning process is Hedlund's (1994) 'knowledge management model'. This model builds on the interplay between articulated and tacit knowledge at four different levels: the individual, the small group, the firm, and the inter-firm domain. This model allows explicit distinctions between knowledge transfer and transformation by three basic set of concepts: (1) articulation (refers to tacit knowledge being made explicit, articulated); and internalisation (is when articulated knowledge becomes tacit), (2) extension (is the transfer of knowledge, possibly resulting in its transformation, from lower (e.g. individual) to higher agency levels (e.g. inter-firm) in the model); and appropriation (is the reverse process to extension, as when the firm teaches new employees about its products or corporate culture), and (3) assimilation and dissemination are conceptually straight-forward concepts covering the input and output, respectively, of knowledge. In this model, articulation is essential in facilitating transform of knowledge. The interplay of tacit and articulation knowledge is termed 'reflection' (Hedlund and Nonaka 1993). The interaction of extension and appropriation is 'dialogue'. Figure 4.2 illustrates this knowledge management model:

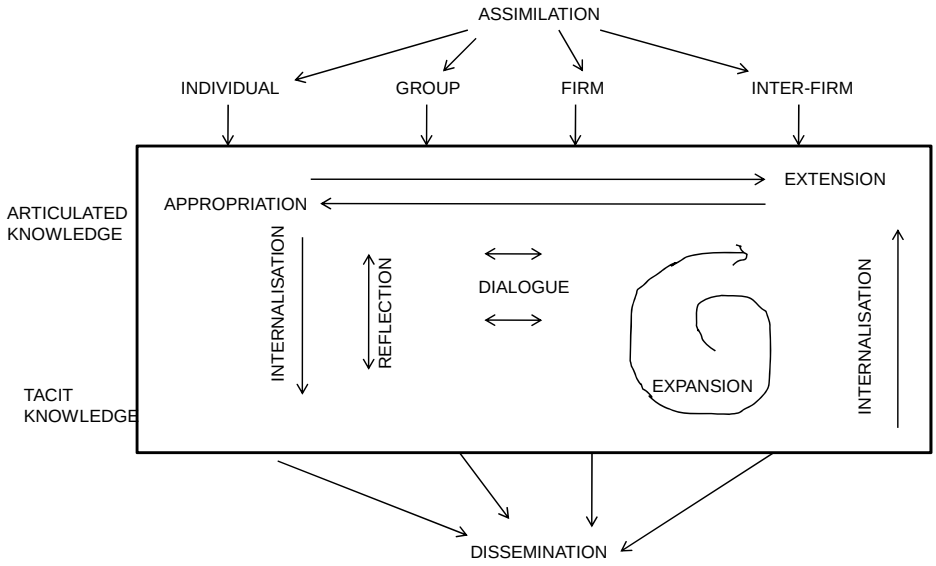


Figure 4.2: Knowledge Management Model (Source: adapted from Hedlund and Nonaka 1993)

Chen, Tong and Ngai (2007) three-step model echoes Hedlund (1994) three inter-firm learning processes. Chen et al. (2007) propose a learning model which contains (1) knowledge acquisition from network which concerns the degree of acquired knowledge from network by integrators; (2) knowledge integration in network which deals with the application of acquired knowledge into development processes and (3) knowledge sharing with network which refers to the dissemination of knowledge generated in development processes within network.

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). The primary obstacle to success is a failure to execute the specific organisational processes necessary to access, assimilate, and disseminate alliance knowledge. Successful firms exploit learning opportunities by acquiring knowledge through 'grafting', a process of internalising knowledge not previously available within the organisation (Inkpen 1996). This process draws scholars' research interests in digging into an organisation's ability of 'grafting' new and external knowledge. For example, in studying creating knowledge through inter-firm collaboration, Inpen (1996) suggested that inter-firm learning mechanism is activated

when a firm (1) creates, (2) gathers, and (3) cross-fertilises knowledge. This mechanism pinpoints that effective knowledge creation through inter-firm collaboration lies in the organisational processes that firms can use to access and transform knowledge. In this sense, new knowledge will not be crated until alliance knowledge is internalised. This internalisation involves a continuous interplay between tacit and explicit knowledge as studied by Nonaka (1994). In studying inter-firm learning, Inkpen (1996) raised the idea of knowledge cross-fertilisation, yet he did not elaborate any further.

Another important process for how inter-firm learning happens comes from the theory of 'dynamic capabilities' (Teece et al. 1997; Zollo and winter 2002; Zahra et al 2006). Dynamic capability has been defined as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (Teece et al. 1997). Dynamic capability highlights the essence of inter-firm learning lies in firm's ability to create, transfer, integrate, and exploit knowledge assets. Zollo and Winter (2002) studied dynamic capabilities and learning, and developed an inter-firm learning mechanism consist three processes: (1) experience accumulation (refers to the central learning process by which operating routines have traditionally been thought to develop), (2) knowledge articulation (refers to the mechanism of developing collective competence, the process through which implicit knowledge is articulated through collective discussions, debriefing sessions, and performance evaluation processes), and (3) knowledge codification (refers to a step to facilitate the diffusion of existing knowledge (Nonaka 1994), an learning effort for knowledge sharing by uncovering the linkages between actions and performance outcomes (e.g. NPD performance appraisals). Their contention is that firms adopt a mix of learning behaviours constituted by an accumulation of experience and by deliberate investments in knowledge articulation and codification activities. Their argument lies in that dynamic capabilities are shaped by the co-evolution of these learning processes. They believe that dynamic capability is a learnt and stable pattern of collective activity through which the organisation systematically generates and modified its operating routines in pursuit of improved effectiveness.

In studying how inter-firm learning is developed and how joint learning outcomes are divided among the allied firms, Larsson et al (1998) proposed five learning types based on the receptivity and transparency of a firm's abilities to absorb and disclose new knowledge in relation to its learning partners'. The five types of inter-firm learning are (1) collaboration: highly receptive and highly transparent; (2) competition: highly receptive and non-transparent; (3) compromise: moderately receptive and transparent; (4) accommodation: non-receptive and highly transparent; and (5) avoidance: neither receptive nor transparent. In this view, inter-firm learning is therefore a joint outcome of the interacting of a firm's choices and abilities to be more or less transparent and receptive. This view of transparency and receptivity is rooted in Hamel (1991) three inter-firm learning dimensions. Hamel summaries the concerns of inter-firm learning into three broad dimensions: (1) concern over the intent of learning partners (collaborative versus competitive, he highlights 'internalisation' of learning partner skills versus mere access); (2) concern over the 'openness' of the firm to its partner, i.e. transparency; and (3) concern over firm's ability to actually absorb skills from its learning partner, i.e. receptivity. In addition to the dimensions of transparency and receptivity as Larsson et al. (1998) studied, Hamel (1991) highlighted 'intent' as one important dimension and emphasises firm's opportunity and the capacity to learn.

International joint venture (IJV) has often been a research target in studying inter-firm. For example, Lyles and Salk (1996) study the knowledge acquisition and performance in IJVs. Beamish and Berdrow (2003) proposed a three-step learning model which contains (1) transfer, (2) transformation, and (3) harvesting. Learning with IJV is found primarily through the transfer of knowledge between partners and from the partners to the IJV (Beamish and Berdrow 2003). Transformation integrates contributed knowledge and competencies, adapts them to the new context and creates new competencies through the joint activities. Harvesting transformed knowledge from the IJV back into the partners' firms enhances other internal or alliance activities that the parent engages in. Most of the literature on collaborative

learning has looked at the transfer of existing knowledge (e.g. Argote et al. 1990; Moenaert and Souder 1990; Hamilton et al. 2004; Modi and Mabert 2007).

In sum, inter-firm learning is often mentioned as one of the means to acquire knowledge and increase the competence of an organisation, within which interaction is a key factor in its process (Huber 1991; Larsson et al. 1998; Zollo and Winter 2002). Various theories address the process of inter-firm learning. Cohen and Levinthal's (1990) 'absorptive capacity' depicts an inter-firm learning process of recognition, assimilation, and application, which reflects a traditional firm's learning view (Cyert and March 1963). Hamel (1991) and Larsson et al. (1998) studied various dimensions (intent, transparency, and receptivity) in learning process. Nonaka (1994) and Hedlund (1994) studied the inter-firm learning process from the perspectives of the interplay between tacit and explicit knowledge. Both SECI model and knowledge management model highlight the concepts of dialogue and articulation in knowledge transfer and transformation. Inkpen (1996) and Teece et al. (1997) studied inter-firm learning process from the view of 'grafting' new knowledge by firms' integration that is tightly linked with knowledge transfer and transformation. Beamish and Berdrow (2003) present a three-step model that consists of transfer, transformation, and harvesting. This model emphasises the importance of dialogue, knowledge integration, externalisation, and shared meaning. Finally, Chen et al. (2007), follow a traditional path, contribute a model of knowledge acquisition, knowledge integration and knowledge sharing in inter-firm knowledge management.

4.3 LEARNING IN BUSINESS NETWORKS

Network Context and Firm's Learning

Håkansson et al. (1999) define network context as entities related to the focal actor. Håkansson and his colleagues see network context is a more broad definition than the relationship context. Imai (2003) views network context as a certain form of multi-faceted inter-firm relationships. An example of a study that uses the concept of network context is that of Holm, Johanson, and Thilenius (1995) who show that from

a control and coordination point of view it is crucial that the division management acquires knowledge about the subsidiary's network context. Firm's learning in network context is both complex and expanding in that different network actors may have different goals and strategies. Powell et al. (1996) characterise such diverse industry networks in biotechnology as the 'locus of innovation', emphasizing the positive benefits of increased rates of firm's learning and access to knowledge on a rapidly developing research frontier.

In studying learning in networks, Håkansson et al. (1999) conclude that the advantage of learning in networks is that it can be more multidimensional and multifaceted compared with interaction taking place in a dyad. Ahuja (2000) highlights two benefits of networking for firm's learning. First, networking provides the benefits of resources sharing, allowing firms to combine knowledge, skills and physical assets. Second, collaborative linkages provides access to knowledge spillovers, serving as information conduits through which information such as technical breakthroughs, new insights to problems, or failed approaches travels from one firm to another. Owen-Smith and Powell (2004) reaffirm that the knowledge spillovers are a function of the firm's commitments and practices of network actors. Firm's business networks thus increase learning and have been described as firm's resources in dealing with uncertainties in changeable business environment (Powell et al. 1996; Gulati, 1999; Håkansson et al. 1999; Owen-Smith and Powell 2004).

Process

The learning process in business networks is a much under-researched area. Up to the thesis writing, a complete network learning process is hardly found. Only bits and pieces of concepts in this regard are revealed in the learning literature. For example, Halme (2001) investigates learning in multi-stakeholder networks, and concludes that the process of learning in network context appears more important than the structure of networks. Halme found that the process may produce exchange-type transactional outcomes or create completely new knowledge, in which network learning actors should be 'as diverse as possible and as similar as possible' (p.112).

On one hand, there need to be different types of member to make broader understanding of knowledge available. On the other hand, the actors of a network need to be able to create a certain amount of common ground in order to act. The idea of 'network evolution' is raised by Halme (2001) to explain a dual guideline of 'small wins but long-term orientation'. Small wins refer to controllable opportunities that produce visible and tangible outcomes to support network learning. A network needs time to become adept at explicating tacit and embedded knowledge to one another, and develop the network so it is fit for creating 'large wins', in that long-term orientation in learning networks is suggested. In other words, it is a process from 'small wins' to 'large wins' that leads to long-term network evolution. In this process, network learning actors should be able and willing to both distribute knowledge to network alliances and integrate knowledge made available by them. Nevertheless, the network learning process remains unclear.

In studying innovation networks in economics, Pyka (2002) presents a concept of 'cross-fertilisation effect' to depict a fusion of different technological capabilities. Pyka believes that it is the fusion of different technological capabilities that the exploration of new opportunities becomes possible. Djelic (2004) studies social networks and has repeated the concept of 'cross-fertilisation', and highlights the importance of transfer and diffusion of knowledge.

In sum, network learning process is a much under-researched area. Some concepts will help for the further research, such as 'network evolution' (Halm 2001); 'cross-fertilisation' (Pyka 2002, Djelic 2004).

4.4 EMBERGENT THEMES AND THEORIES

Several themes have been touched upon in this study and would require further review in the related literature. The first theme is in regard to knowledge, in which the link between knowledge and information, the nature of knowledge (tacit and explicit), and the knowledge transfer and transformation are discussed. The second theme concerns the theory of experience, in which exploitation, exploration, and

unlearn are discussed. The third theme involves practice in related to learning, in which two emergent concepts, dialogue and articulation, are discussed.

Knowledge and Information

In distinguishing the differences between knowledge and information, Dretske (1981) offers some useful definitions. In his words:

> *Information is that commodity capable of yielding knowledge, and what information a signal carries is what we can learn from it (p.44). Knowledge is identified with information-produced (or sustained) belief, but the information a person receives is relative to what he or she already knows about the possibilities at the source (p.86).*

In this sense, knowledge is viewed as objects and products of learning, such as information (data that give meaning by reducing uncertainty and ambiguity), beliefs about cause-effect relationships, experience, and know-how (Glaser 1991; von Hippel 1989; Ahuja 2000, Kogut and Zander 1992; van der Bij, Song and Weggeman 2003). Information-processing systems further help to understand the formation of knowledge (Day 1994; Sinkula et al. 1997; Slater and Narver 1995; Zahay and Handfield 2004). The formation of knowledge requests four firm's capabilities:

1. Generation (get or acquire): process and systems to collect information (Kohli et al. 1993).
2. Memeory (store): processes and systems to store information for future use, new scale (Zahay and Handfield 2004)
3. Dissemination (move): processes and systems for diffusing information horizontally and vertically throughout the organisation (Kohli et al. 1993)
4. Interpretation (use): processes that give information one or more commonly understood (shared) meanings that are used in that organisation, new scale, based on prior work in this area (Zahay and Griffin 2003).

In short, information is a flow of messages, while knowledge is crated and organised by the very flow of information, anchored on the commitment and beliefs of its holder. This understanding emphasised an essential aspect of knowledge that relates to human and firm's action in learning.

Nature of Knowledge - Tacit and Explicit

Polanyi (1966) classified human knowledge into two categories. 'Explicit' or codified knowledge refers to knowledge that is transmittable in formal, systematic language. On the other hand, 'tacit' knowledge has a personal quality, which makes it hard to formalise and communicate or share with other firms. Tacit knowledge is deeply rooted in action, commitment, and involvement in a specific context, such as networks (Nonaka 1994). Hedlund (1994) sees tacit knowledge nonverbalised, intuitive, unarticulated; and sees articulated knowledge specified either verbally or in writing, computer programs, patents, drawings or the like. Tacit knowledge involves intangible factors embedded in personal beliefs, experiences, and values; and explicit knowledge is systematic and easily communicated in the form of hard data or codified procedures. The interplay between tacit and explicit knowledge has been the main topic in many studies in learning, for example, SECI process (Nonaka 1994), knowledge management model (Hedlund 1994).

Knowledge Transfer and Transformation

The knowledge transfer has been viewed as the centre of the firm's processes between a parent company and its alliances (Inkpen 1996; Marsh and Stock 2003; Carlile 2004). It comes from a mature root in the literature of learning – the process of accessing, assimilating, and disseminating information (Cyert and March 1963; Daft and Weick 1984; Cohen and Levinthal 1990; Moorman 1995; Inkpen 2000). The concept of 'transfer' has its basis in the information-processing approaches to boundaries in organisation theory (Lawrence and Lorsch 1967; Galbraith 1973). The primary concern is one of 'processing' or transferring knowledge across it. The information-processing approach is the dominant view used to describe managing firm's learning (Slater and Narver 1995; Sinkula 1994). The information-processing

approach, however, has been argued as problematic when novelty makes some differences and knowledge ambiguous (Nonaka and Takeuchi 1995).

Researchers who adopt an interpretive approach recognise how different domains (i.e. thought worlds) naturally generate interpretive differences and so emphasize process that helps create 'shared meanings' (Dougherty 1992) or mechanisms to reconcile discrepancies in meaning (Nanaka and Takeuchi 1995), and have paid attention to the distinction between tacit and explicit knowledge (Polyani 1966) to recognise the situated and interpretive challenges of moving knowledge across boundaries (Nonaka and Takeuchi 1995; Spender 1996). Furthermore, von Hippel and Tyre's work (von Hippel 1994, Tyre and von Hipple 1997) calls attention the stickness of situated knowledge when trying to move it across different domains. Nonaka's (1994) description of the process of 'externalisation', or Hedlund's (1994) description of the process of 'articulation', making tacit knowledge explicit, has been recognised as one of the most critical processes firms need. All of this research acknowledges the importance of developing common meaning as a way to address interpretive differences across boundaries. Bresman, Birkinshaw and Nobel (1999) see knowledge transfer from a reciprocal perspective and claim that knowledge may be transferred in either or both of the following directions: from the acquiring firm to the acquired firm; from the acquired firm to the acquiring firm, in which they term as 'reciprocal knowledge transfer'.

In relation to assimilating new knowledge, Bechky (2003) explains the knowledge transformation as it occurred 'when a member of one community came to understand new knowledge from another community fit within the context of his own work, enriching and altering what he knew' (Bechky 2003, p.321). In the knowledge transformation, the understanding (e.g. of the product, process, or organisation) is expanded, not merely by the introduction of new knowledge 'transferred' by partner firm, but by placing that knowledge into practice in such a way that it induces a new light, that is the ability of knowledge transformation creates broader shared minds. In order to develop shared minds between firms that had different work contexts and background, actors have to co-create some common ground (Clark 1996). Common

ground is the 'sum of mutual, common, or joint knowledge, beliefs, and suppositions' (Clark 1996, p.93).

The potential for knowledge transformation exists any time learning actors are placed in new situations or are presented with new ideas. Alliances bring together firms with different technologies, markets and experiences. Quinn (1992) called this 'cross-functional serendipity' and claimed "the interaction between skilled people in different functional activities often develops unexpected new insights or solution". According to Marshall and Brady (2001), knowledge integration may codify the knowledge into new knowledge development, which conduces to finding solutions for similar problems in future development. Doz (1996) emphasised the importance of transforming contributed knowledge in order to succeed in collaborated networks. This 'contextual' view of learning is differentiated from a static perspective of the transfer of existing knowledge.

In studying knowledge management and firm's learning, Carlile and Rebentisch (2003) propose the theory of 'knowledge transformation cycle' which addresses the complexity of the knowledge integration. As mentioned earlier, knowledge transformation cycle consists of storage, retrieval and transformation, and it goes as a cycle, never ends. Through the perspective offered by the knowledge transformation cycle, the amount of novelty (i.e. new knowledge) present from one cycle to the next becomes the key to determining the contingencies surrounding the types of activities required for successful knowledge integration between knowledge transfer and transformation.

Exploitation and Exploration

In studying learning, there are two distinct approaches of how learning taking place. One learning approach is the marginal refinement of existing practices as experience accrues. Another approach yields more radical, and innovative improvements. March' (1991) 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, March (1991) argued that both exploration and exploitation are essential for organisations, but they compete for scarce resources; consequently, he believed that there is an 'either/or' trade-off choice an organisation has to make between exploration and exploitation. This trade-off contention was reviewed and given new explanations by another group of scholars (for example, Kyiakopoulos and Moorman 1998, 2002; Dickson 1992; Leonard-Barton 1992).

A central concern of adaptive processes studies 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 (Levinthal and March 1981). Kyiakopoulos and Moorman (1998, 2002) believed that market learning is the development of new knowledge about the markets generated through various organisational information processes (Day 1994; Huber 1991; Moorman 1995). They stressed that the exploitative market learning contributes firms' transactional costs reduction, and thus expedites decision making, implementation and control; and exploratory market learning generates new knowledge that extends the current capabilities.

Exploitative learning and exploratory learning, therefore, take place for different purposes at different level. First, it was suggested that there is an optimum point of exploitation, beyond which it can be expected to see experience and memory cease being a value asset (Kyiakopoulos and Moorman 1998). Thus, explorative learning

needs to replace exploitative learning. Nonetheless, an over-reliance on exploration can be equally detrimental. There is a point that organic organisational structures typically associated with exploration fail to deliver, as explorers are unable to build internal learning capacity. This capacity is tightly linked with *absorptive capacity* proposed by Cohen and Levinthal (1990). Without such capacity, research has shown they will be less successful at recognising and assimilating external knowledge (Cohen and Levinthal 1990). It is also believed that in certain circumstances exploitative learning is valuable because it contributes to efficiency described by the 'learning curve effect' (Yelle 1979). Mitchell's (1989) found that industry-specific capabilities increased when a firm could exploit a new technology within that industry. However, a growing body of literature points to the limits of exploitative learning because it creates 'functional fixedness' (Dickson 1992; Leonard-Barton 1992). Departing from March's (1991) trade-off theory, Leonard-Barton (1992) believed that firms are facing a paradox: firms' existing core capabilities *simultaneously* enhance development where exploitative learning is cultivated, and inhibit development where explorative learning is hindered. How to take advantage of the exploitative learning without being hampered by their dysfunctional flip side challenges managers and scholars' minds. In resolving this issue, the theory of 'unlearning' was raised by another group of scholars (Hedberg 1981; Nystrom and Starbuck 1984; Hamel 1991; Huber 1991), who believed that learning often cannot begin until unlearning has taken place. Unlearning highlights the issue that exploitation may inhibit learning where exploration is hindered, and searches a solution to the issue.

Unlearning

Hedberg (1981) is an early and frequently cited reference on unlearning. He defines unlearning as 'a process through which learners discard knowledge' (p.18). By emphasising unlearning as the discarding of 'obsolete and misleading knowledge (p.3), he implies that unlearning is functional, and perhaps intentional, that is said 'to forget', which means not only 'to lose the remembrance of', but also means 'to disregard intentionally'. In short, unlearning can be seen as the process by which firms eliminate old logics and make room for new ones (Prahalad and Bettis 1986).

Unlearning departs from a belief of 'past learning inhibits new learning' (Huber 1991; Nystrom and Starbuck 1984; Sinkula 2002), and it possesses some essential effects. First, when a firm unlearns, it is without a fact, belief, or script that it previously used, it becomes at least temporarily inactive in the context where this knowledge had been used. If there is impetus for action, the second effects of unlearning is that focused search is initiated to obtain a substitute fact, belief, or script that plays a parallel role in the organisation's functioning. This effect leads to the third effect of unlearning which is that unlearning opens the way for new learning to take place.

Before firms try new ideas, they must unlearn old ones by discovering their inadequacies and then discarding them. An example is firms in serious crises often remove their top managers as a way to erase the dominating ideas, to disconfirm past programs, to become receptive to new ideas, and to symbolise change. Not surprisingly, Day (1994) highlighted firms that '*the presumed correctness of past actions and interpretations is reinforced by repeated success, and the ensuing complacency breeds rejection of information that conflicts with conventional wisdom'* (p.24). And Sinkula (2002) believed that for unlearning to occur at an firm's level, 'forgetting' must first take place to allow firms to operate with a 'clean slate'.

What firms learn, therefore, is not jaded by the experience lessons of history, but it is unlearning that makes way for new responses and mental maps. Nonetheless, routines that have been successful in the past are quick to inhabit firm's memory and narrow an organisation's vision. Numerous writers have written about the poisonous side effect of success (Daft and Weick 1984; Nystrom and Starbuck, 1984; Sinkula 1994). It is claimed that organisations will not unlearn until a forced power occurs. Forced unlearning is often caused by environmental uncertainty and external phenomena. It is also found that organisations that face dynamic, hostile environments unlearn more frequently and faster than those that face static, benevolent environments (Sinkula 2002; Day and Nedungadi 1994). In sum, as Hedberg (1980) mentioned that 'there are times when firms should treat their

memories as enemies', the ability of unlearning allows firms an ability to see the right stimuli and choose the appropriate development.

Dialogue

The emergence of the concept of dialogue is one of the most significant recent developments in the theory and practice of firm's learning (Beeby and Booth 2000; Schein 1993). The word dialogue comes from two Greek roots, *dia* and *logos*, suggesting 'meaning flowing through'. Isaacs (1993) defines dialogue as 'a sustained collective inquiry into the processes, assumptions, and certainties that compose everyday experience. In this sense, the central purpose of dialogue is to establish a field of genuine meeting the inquiry – a setting in which people can allow a free flow of meaning. In studying dialogue, Hazen (1994) suggests that 'to name one's experience in dialogue and to be heard and responded to by the other is to reflect on that experience and, doing so, actively change the context in which it occurs" (p398). She approaches dialogue as a method of inquiry and a process of change, and postulates that dialogue occurs 'when people speak with and listen to one another in mutuality, reciprocity and co-inquiry, thus changing their shared reality" (p.398). Dialogue allows participants in a relationship to reach a shared mental model, which assists not only the embodiment of shared knowledge but also it actual utilisation. That said, the discipline of dialogue is central to firm's learning because it holds promise as a means for promoting collective thinking and communication (Cyert and March 1963; Beamish and Berdrow 2003).

Issacs (1993) has well elaborated the relationship between dialogue and firm's learning. First, firms face a degree of complexity that requires intelligence (or knowledge) beyond that of any individual. To solve problems in complex system, by using dialogue, firms learn to tap the collective intelligence of groups of knowledgeable people. Further, the practice of dialogue focuses on uncovering and inquiry into the feedback loop between the internal interpretive structures which then influence the world and our internal structures. Often, 'fragmentation' is a condition of thought, and dialogue is one tentatively demonstrated strategy for stepping back from the way of thinking produced by fragmentation and incorporating another way

of thinking. In this sense, dialogue is an attempt to perceive the world with new eyes, not merely to solve problems using the thought that created them in the first instance. This using dialogue for an attempt to perceive the works with new eyes is what inter-firm learning is looking for. As Schein (1995) highlights that since problem solving and conflict resolution in groups is important, dialogue is imperative; in that dialogue is a basic process for building common understanding. Beeby and Booth (2000) suggest that the theory and practice of dialogue is currently the most powerful available means for the facilitation of learning between firms. Only with dialogue is it possible to determine whether or not the communication between firms is valid. As Nonaka and Toyama (2002) indicated that a firm is a dialectical being, within which dialogue helps firms to unveil the ways in which collective patterns of thinking and feeling unfold. Today, firms are facing many contradictions: a firm has to achieve global integration and local adaption at the same time; and it faces various contexts in terms of its employees, customers, suppliers, related firms. Yet it has to share context within and across the firm to function efficiently. To achieve this, companies engage in dialogue.

Articulation

Grant (1996) has pointed out that knowledge integration is the key organisational capability of the firm, and suggests that only until tacit knowledge turns into explicit that knowledge can be integrated through learning networks. The process turns tacit knowledge into explicit heavily lies in a process called 'articulation' (Hedlund 1994; Nonaka and Toyama 2003). Hedlund (1994) sees 'articulation' as tacit knowledge being made explicit, articulated. Hedlund claims that many firms are 'articulation machines', built around codified practices. Articulation is essential in facilitating transfer of knowledge. As discussed earlier, the nature of underlying knowledge will have an important impact on the knowledge transfer process. That is, if the knowledge is tacit, and thus not readily to be transferred. It is articulated knowledge is likely to be quite straightforward to transfer among learning actors (Nanaka 1994; Hedlund 1994; Bresman et al. 1999).

The theory of 'ba' (place) (Nonaka 1994) highlights the importance of 'externalisation' for articulating tacit knowledge into explicit. Tacit knowledge is hard to communicate and is deeply rooted in action, involvement and commitment within a specific context; it is 'a continuous activity of knowledge' (Nonaka 1994, p16); it is 'the way things are done around *here*' (Spender 1996, p54). Giving that poorly articulated knowledge is difficult to teach and learn, such knowledge can be more difficult to transfer between firms (Cummings and Teng 2003). In order to turn tacit knowledge to explicit and easily transferable, Von Hippel and Katz (2002) develop the idea of 'toolkits' and highlight the importance of 'learning by doing'. Related studies point out that 'learning by doing' is helpful to articulation in that when actors are actually being drilled in the process of learning how to utilise the conceptual knowledge that they have learned, they are better able to increase their knowledge applicative capability (Nonaka and Takeuchi 1995; Tsang 2002; Tsai et al. 2006). In studying inter-firm knowledge creation, Holmqvist (1999) highlighted that the articulation mechanism is typically triggered by dialogue or collective reflection. According to Holmqvist (1999), through reflective conversation, tacit knowledge was shown to be detected and articulated into explicit knowledge. By discussing with an 'outsider' (e.g. network partner) with different background and tradition, both parties are likely to increase their knowledge base. Knowledge is 'hidden' (or tacit) that may be important for a learning partner to understand. This is the reason why firms should take time to reflect on their 'taken-for-granted' behaviour so that 'outsiders' (or network partners) are able to understand and share with them their knowledge.

4.5 IMPLICATION AND CONCLUSION

Learning is a process of putting cognitive theories into action, and is tightly linked with environmental change and experience (Daft and Weick 1984). A firm's learning has been seen as an information process (Sinkula 1994; Slater and Naver 1995; Day 2002). It focuses on how firms acquire, dissimilate, and apply information as they gain experience in responding the environmental change (Cyert and March 1963; Cohen and Levinthal 1990; Weick and Westley 1996; Halme 2001; Beamish and Berdrow 2003). The information-processing approach has been the

dominant view used to describe managing firm's learning (Sinkula 1994; Slater and Narver 1995; Day 2002). The information-processing approach however has been argued for its incompleteness from an interpretive view (Nonaka and Takeuchi 1995). The interpretive view emphasises the process to create 'shared meaning', the interplay between tacit and explicit knowledge, and the distinction between the knowledge transfer and the knowledge transformation (Dougherty 1992, Nonaka 1994; Hedlund 1994).

The study in inter-firm learning process is rich. Following the traditional view of firms' learning, Cohen and Levinthal's (1990) absorptive capacity depicts firm's ability to acquire, dissimilate and apply information from other firms. Prior studies have suggested that firms business relationships accommodate firms not only hold specialised knowledge but also have the opportunity to learn from alliances (Powell et al. 1996; Dyer and Nobeoka 2000; von Hippel 2007). Inter-firm links are an important part of a learning process in which firms discover new opportunities and obtain new knowledge through interacting with one and another (Håkansson 2006; Ford et al 2006). Many studies contribute to the understanding on the inter-firm learning process. For example, Nonaka (1994) and Hedlund (1994) highlight the process of knowledge transfer and transformation through socialisation, externalisation, combination and internalisation. Inkpen (1996), Teece et al. (1997), Beamish and Berdrow (2003) present the theories of create, cross-fertilisation and transformation.

Firm's learning into network context is more multifaceted compare with interaction taking place in inter-firm learning. Firm's business networks provide two benefits for firm's learning (Ahuja 2000). First, networking provides the benefits of resources sharing, allowing firms to combine knowledge, skills and physical assets. Second collaborative linkages in business networks provides access to knowledge spillovers serving as conduits for technical breakthroughs, new insights to problems travels from one firm to another.

Network learning process is a much under-researched area. Limited studies in this area and only bits and pieces of concepts are presented, such as network evolution (Halme 2001), and cross-fertilisation (Pyka 2002; Djelic 2004). Up to this writing, there is virtually no research that tries to conceptualise and empirically analyse network learning process. Further research is required. Table 4.1 illustrates key studies reviewed on firm's learning process, inter-firm learning process, and learning in network process. More details of their implication to the present study will be discussed in the following chapters.

Scholars (Year)	**A firm's learning Process**	**Implication to the Study**
Cyert and March (1963)	Three steps: (1) to ask the right question at the right time; (2) to absorb the answers, share understanding of implications; and (3) to act decisively.	Information processing has been the dominant view for managing firm's learning. A process of acquisition, transmission, assimilation and application sets up a fundamental framework.
Daft and Weick (1984)	Three-stage model: (1) scanning (2) interpretation (3) learning.	
Huber (1991)	Four constructs: (1) knowledge acquisition (2) information distribution (3) information interpretation (4) organisational memory.	
Slater and Narver (1995)	Three-stage market information process: (1) information acquisition (2) information dissemination (3) shared interpretation.	
Day (2002)	Three activities: (1) sensing activities (2) sense-making activities (3) reflection.	
Scholars (Year)	**Inter-firm Learning Process**	**Implication**
Cohen and Levinthal (1990)	Absorptive capacity: (1) to recognise; (2) to assimilate; and (3) to apply.	1)Interaction is a key factor in this process. 2)Several studies reflect the traditional view of acquisition, assimilation, dissemination. 3)Inkpen (1996), Teece et al. (1997), Beamish and Berdrow (2003) highlight the theories of create, cross-fertilisation, transformation and harvesting in inter-firm learning process.
Hamel (1991)	Inter-firm learning dimensions: (1) intent; (2) transiency; (3) receptivity.	
Nonaka (1994)	SECI process: (1)Socialisation; (2)Externalisation; (3)Combination; and (4)Internalisation.	
Hedlund (1994)	Three processes: (1) assimilation; (2) transformation; (3) dissemination. Emphasising knowledge transfer and transformation.	
Inkpen (1996)	Grafting new knowledge: (1) to create; (2) to gather; and (3) to cross-fertilise.	
Teece et al. (1997)	Dynamic capabilities: (1) to integrate; (2) to build; and (3) to reconfigure.	
Larsson et al (1998)	Inter-firm learning types: (1) collaboration; (2) competition; (3) compromise; (4) accommodation; (5) avoidance.	
Zollo and Winter (2002)	Co-evolved dynamic capabilities: (1) experience accumulation (2) knowledge articulation; (3) knowledge codification.	
Beamish and Berdrow (2003)	Three-step model: (1) transfer; (2) transformation; (3) harvesting. Emphasising dialogue; knowledge integration; externalisation; shared meaning.	

Chen, Tong and Ngai (2007)	Knowledge management model: knowledge acquisition, knowledge integration and knowledge sharing	
Scholars (Year)	**Network Learning Related Studies**	**Implication**
Halme (2001)	Learning in tourism networks: small wins to large wins that lead to long term network evolution.	Under-researched area, especially in the process.
Pyka (2002)	Innovation networks: cross-fertilisation effects of different technologies.	
Djelic (2004)	Social networks: dense and weak ties in the diffusion of knowledge	

Table 4.1: Key Studies in the Learning Literature (Source: Author)

CHAPTER 5

THE SYNTHESIS
AND
CONCEPTUAL FRAMEWORK

CHAPTER FIVE

5.0 Introduction

5.1 The Synthesis

5.2 Research Gap

5.3 Research Question

5.4 Conceptual Framework

5.5 Conclusion

5.0 INTRODUCTION

This chapter aims to provide a synthesised view based on the discussion in the preceding literature review, and to present the conceptual framework based on the research gaps and research questions. It first synthesis key conclusions drawn from three chapters' (chapter 2-4) literature review, followed by identified research gap. It then proposes research questions and the conceptual framework for further study.

5.1 THE SYNTHESIS

In reviewing the NPD literature, the five NPD models (Saren 1984) help for a basic understanding of NPD and look into the NPD process from various perspectives. The six research themes suggested by Craig and Hart (1992) guide a more thorough review into NPD studies. The NPD process is tightly linked with uncertainty and cycle time reduction (process themes), and the empirical evolution, from the cross-functional coordination to business network collaboration (the people theme); from information processing to knowledge creation (the information theme), is revealed. The three research streams proposed by Brown and Eisenhardt (1995) provide guidelines for a more integrated review into the NPD literature. The problem solving stream is drawn from the perspective that successful NPD involves relatively autonomous problem solving by actions such as inter-firm collaboration. Studies from the communication-web perspective highlight the use of sources (both internal and external) of information and knowledge towards NPD success, within which the interactive and iterative communication with outsiders has drawn many researchers' attention (e.g. Dougherty 1992; Ancona and Caldwell 1992). The result of the NPD literature review leads to a further review on the business relationships and in searching a better understanding of inter-firm relationships and business networks and how information and knowledge is managing in these relationships.

In dealing with continuous changing and competitive environment, firms seek collaborative relationships with other firms, in which inter-firm relationships and business networks are formed. In inter-firm relationships, interaction and

interdependency between firms are emphasised (Håkansson 1982). Business networks, on the other hand, are complex and difficult to define. It derives from a set of embedded relationships with other firms in which nodes and threads with dynamic interactions among firms are stressed (Granovetter 1985; Ahuja 2000; Håkansson et al. 2002). In seeking NPD success, firms involve the dynamic interactions through networking for that it provide diversified access of the transfer from firms that have the capabilities and experiences to those which seek to use them. The result of the business relationships literature review leads to a further review on how the information processing and knowledge creation is operated in these relationships, namely learning, specifically in learning process.

The review of firm's learning process helps the understanding of inter-firm learning process, in turn helps the study in business network learning process. Firm's learning has been viewed as experience based improvement through a process of acquisition, transmission, and application (Cyert and March 1963; Argyris and Schon 1978). In this sense, firm's learning can be viewed as an information process (Daft and Weick 1984; Huber 1991). Inter-firm learning can be viewed as a joint outcome of firms' interaction (Larsson et al. 1998; Hamel 1991; Inkpen 1996). The information processing approach and the interpretive view of knowledge are two main streams in studying inter-firm learning process. The information processing (acquire, dissimilate, and apply) has been the dominant view in managing inter-firm's learning (Sinkula 1994; Slater and Narver 1995; Day 2002). Studies from the interpretive view, on the other hand, emphasis the process of creating 'shared meaning, in which the interplay between tacit and explicit knowledge and the knowledge transfer and transformation are at the heart of these studies (Nonaka 1994; Hedlund; Nonaka and Takeuchi 1995). Firm's learning into network context is more multifaceted compare with interaction taking place in inter-firm learning. The integrated and incremental benefits are stressed in business network learning. That said, networking allows firms to combine knowledge and provide access to knowledge spillovers service as conduits for technical breakthrough and new insights in the areas such as NPD.

Several key conclusions are evidentially drawn from the literature review. First, product development is essential to the long term success of the industrial company, in that a company's ability to improve the NPD process (aiming to drive product development from idea to launch effectively and efficiently), is critical to this long term success (Craig and Hart 1992; Saren 1984; Booz, Allen, and Hamilton 1982; Cooper and Kleinschmidt 1991; Crawford 1983; Calantone and Durmusoglu 2007). Second, any NPD, by nature, exhibits uncertainty and high risk, in that companies require careful NPD planning, well communication web through multilevel learning and knowledge creation to solve problem (such as uncertainty reduction and speed-to-market), and thus to reach NPD success (Brown and Eisenhardt 1995; Moenaert and Souder 1990; Imai et al. 1985; Takeuchi and Nonaka 1986; Macher and Mowery 2009). Third, companies increasingly see alliances with other firms as a way to create successful new products, in that, resources complementary and competence extension are highlighted as the driving forces. Companies rely on collaborative relationships in the tightly networked business markets to access, survey and exploit emerging technological and product development knowledge (Håkansson et al. 2002; Ford et al. 2002; von Hippel 2001; Powell et al. 1996; Ahuja (2000); Uzzi and Lancaster 2001; Rindfleisch and Moorman 2001). Finally, a key feature of business networks is their capacity to promote learning, in that business networks provide an access to information flow, knowledge creation and experience exchange and NPD needs this access to transfer information and create knowledge and experience (Biemans 1992; Håkansson and Snehota 1995; Powell 1996; Gulati 1999; Sivadas and Dwyer 2000; von Hippel 2007; Johnson 2008).

Further, contradictory views have been found in the literature review. For example, in studying knowledge transfer, the information-processing approach has been dominant view used to describe managing of a firm's learning (Slater and Narver 1995; Sinkula 1994). Nevertheless, the information-processing approach has been argued by researchers who adopt an interpretive approach as problematic when knowledge is tacit and difficult to get across companies' boundaries (Nonaka and Takeuchi 1995). In studying 'experience' in inter-firm learning, one group of researchers highlights the importance of engaging in 'experience' in facilitating

knowledge exchange (Levitt and March 1988; Powell 1998; Michael and Palandjian 2004). Another group of scholars claims the negative effect of 'experience' in accommodating learning (Hedberg 1981; Weick 1993; Michael et al. 2004). Finally, knowledge transfer has been viewed as a key factor for uncertainty reduction and speed-to-market in NPD (Souder and Moenaert 1992; Parry et al. 2009; Langerak et al. 2008). However, different views have been discussed in extant research (e.g. Appleyard et al. 2006; Hirsch and Meyer 2010). In short, in seeking better product development performance, the literature review has established that inter-firm learning in firm's business networks is of importance to NPD success. However, the literature does not provide a clear explanation of how inter-firm learning in NPD networks takes place. Figure 5.1 shows a literature map that illustrates the synthesis from the literature review of three areas:

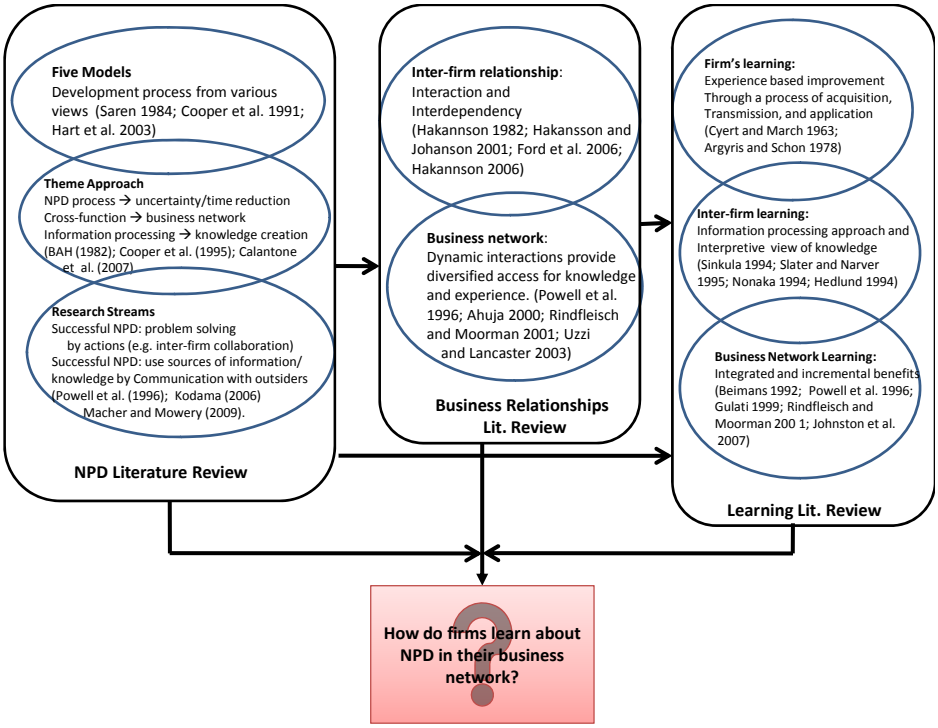


Figure 5.1: Literature Map (Source: Author)

5.2 RESEARCH GAP

Despite business network learning being claimed as an important managerial practice in NPD, the literature does not provide a clear explanation of how this learning takes

place in firms' business networks when developing products. The research gap is threefold. First, as society is increasing turning into a 'knowledge economy' (Drucker 1993; Nonaka and Toyama 2002), the importance of knowledge as the inputs and outputs of firm's learning activities has increased, which is especially critical to NPD. The learning literature has established various mechanisms in information processing and knowledge management. Nonetheless, answers to the questions of 'Are those suggested mechanisms appropriate for NPD?' 'Is there a more appropriate business network learning process that helps firms to develop new products?' are still unclear. Second, the literature into firms' and inter-firm learning is rich and provides guidelines for how existing knowledge is transferred and how new knowledge is created in one firm and between firms (e.g. Cohen and Levinthal 1990; Hamel 1991; Nonaka 1994; Hedlund 1994; Inkpen 1996; Teece et al. 1997; Larsson et al. 1998; Zollo and Winter 2002). For example, the SECI model provides a process of socialisation, externalisation, combination, and internalisation in transferring knowledge (Nonaka 1994). The knowledge management model proposes the engagement of dialogue and reflection in the knowledge transfer and transformation (Hedlund 1994). In recent years, scholars have called for a transformation of a 'new' market paradigm where managers' roles will increasingly shift away from the dyadic paradigm towards to a network paradigm (Powell et al. 1996; Håkansson et al. 2000; Ford et al. 2000). Nonetheless, when studying learning into business network context, the existing literature of inter-firm learning literature is insufficient for the understanding of how business network learning. For example, the contradictory views to 'knowledge transfer' and the impacts of 'experience' on knowledge exchange. Finally, the notion of information and knowledge closely associated with uncertainty reduction and NPD cycle time reduction is reiterated throughout the NPD literature (e.g. Souder and Moenaert 1992; Griffin 1997; Eisenhardt 1989). Nonetheless, the empirical research into the impact of the learning process (within which information and knowledge are managed) on the NPD uncertainty reduction and NPD speed to market is rather limited.

In sum, the synthesis from cross linking literature strands has indicated that NPD is in itself the outcome of network collaboration and the result of inter-firm learning.

Nonetheless, despite business network learning being claimed as an important managerial practice in NPD (e.g. Powell et al. 1996), the literature does not provide a clear explanation of how firms learn about NPD in their business networks. Nor has sufficient empirical research yet been undertaken.

5.3 RESEARCH QUESTION

The literature review in cross-linked threads has provided extensive insights in relating to the research topic. The research gap as discussed has substantiated that there is a need to understand how firms learn about product development in their business networks. This study aims to bridge the gap that helps to link learning, business networks and product development by asking the following questions:

Main Research Question

How do firms learn about NPD
in their business networks?

In exploring the main research question, three sub-questions are proposed for investigation. First, the literature into how firms learn contributes many models and theories in regard to its process and mechanisms; for example, an early widely cited learning model of to ask, to share and to act suggested by Cyert and March (1963); Nonaka's (1994) SECI process; Hedlund's (1994) knowledge management model; and Beamish and Berdrow's (2003) three-step model (transfer, transformation, and harvesting). Nonetheless, we know so little about how firms learn in their NPD networks, especially in successful NPD projects. A successful new product development project is defined as a NPD project that has been brought from idea to commercial success (BAH 1982; Cooper 1984). This study thus proposes its first research question:

Q1: How is business network learning processed in successful new product development?

Second, business network learning is still an under-researched topic (Inkpen 2000; Håkansson et al. 2002). Firm's learning into network context is more multifaceted compare with interaction taking place in inter-firm learning. The literature of inter-firm learning helps the study in business network learning, yet it is not sufficient to grab a clear picture of how business network learning takes places. Some concepts have been brought up to shed some lights in differentiating business network learning from inter-firm learning; for example, the concepts of cross-fertilisation (Inkpen 1996; Pyka 2002); network evolution (Halme 2001) and cross-functional serendipity (Quinn 1992). However, there is very little research that tries to conceptualise these concepts. More importantly, studies in inter-firm learning have noted some firm's engaged attributes that are critical in the learning process such as interaction and dialogue (Nonaka 1994; Hedlund 1994; Inkpen 1996; Larsson et al. 1998). Nonetheless, we know so little about what firm's engagements attribute to the learning process in business network context, especially in the area of NPD. This study aims to first investigate the NPD network learning process, and then find out the firm's engaged attributes that construct the proposed NPD network learning process. Thus, the second research question is:

Q2: How do firms engage with their business alliances in the NPD network learning process?

Finally, learning has been viewed as a conduit that provides access to knowledge and information spillovers (Ahuja 2000; Owen-Smith and Powell 2004); and the notion of knowledge and information closely associated with NPD uncertainty and cycle time reduction is well accepted (Souder and Moenaert 1992; Griffin 1997; Eisenhardt 1989). Nevertheless, we know so little about how the business network learning impacts on NPD uncertainty and cycle time reduction. This study aims to propose a NPD network learning model through investigating the NPD network learning process and firms' engaged attributes that construct this process, then to examine how the proposed model affects NPD uncertainty reduction and speed-to-market. Therefore, the third research question for this study is:

Q3: How does the business network learning mechanism impact on uncertainty reduction and speed-to-market in successful NPD?

5.4 CONCEPTUAL FRAMEWORK

Based on the proposed research questions, a conceptual framework is laid out. To facilitate the research, this study followed the six distinct stages in NPD process suggested by Booz, Allen and Hamilton (1982), namely, idea exploration, idea screening, business analysis, development, testing, and commercialisation. In this study, successful NPD is of interests. Based on the six stages process, a successful NPD is defined as the one that has been brought from idea to commercial success. Along with the six NPD stages, an exploratory research is proposed to first find out firm's business network learning process in their successful NPD projects and firms' engagements construct this process, followed by a research in examining how the proposed research model impacts on NPD uncertainty reduction and speed-to-market. A conceptual framework is thus proposed for field study. Figure 5.2 illustrates the framework:

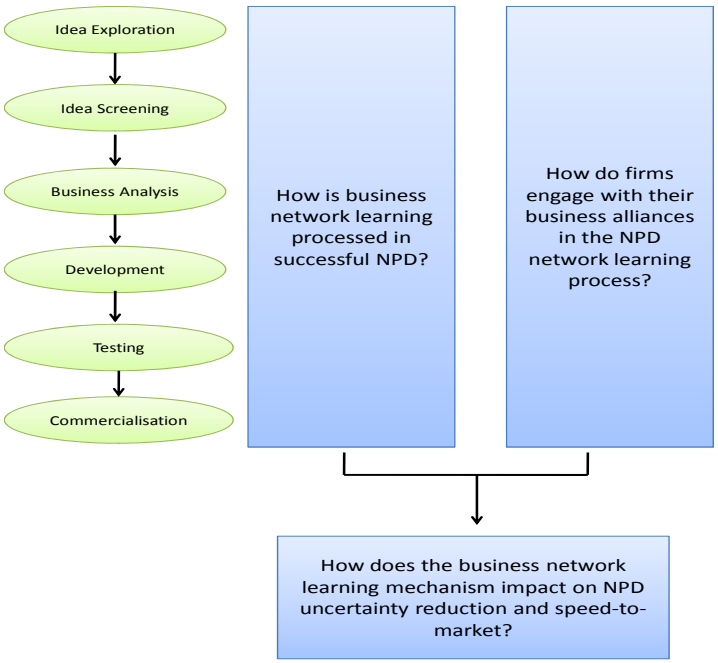


Figure 5.2 Conceptual Framework (Source: Author)

5.5 CONCLUSION

The notion that learning leads to product success is pervasive in the literature (e.g. Powell, 1996, 1998, 2005; Dickson et al., 2001; Easterby-Smith and Araujo, 1999). Indeed, business market situations are continually being transformed that forcing firms have no other options but continually to learn and adapt. This is especially true in today's NPD. As product development becomes more complex, knowledge tends to be scattered among large number of organisations, and firms often need to collaborate when seeking to harness this knowledge (Baldwin and Clark 2000; Beamish and Berdrow 2003). The conceptualisation of inter-firm learning in NPD networks in this study is based on a knowledge-based view of the firm and on the argument that understanding learning requires an understanding of how knowledge moves across firm boundaries. Many scholars claimed that the drive to turn new knowledge and competencies into NPD success lies in inter-firm learning in collaborative NPD networks (e.g. Powell et al. 1996; Håkansson and Johanson 2001; Appleyard 2003; Marsh and Stock 2003). That said, the dynamic process of developing new capabilities in NPD lies in the 'collective learning' and the use of the knowledge learnt by the organisation in the NPD process. The synthesis of the literature review has revealed that how firms learn about NPD in collaborative business networks is much less understood. A conceptual framework is proposed with the intention of reducing gaps in the study area.

CHAPTER 6

RESEARCH METHDOLOGY

CHAPTER SIX

6.0 Introduction

6.1 Philosophical Stance

Philosophical Assumptions

Shaping Research Orientation

The Study – Pragmatism and Mixed Method Research

6.2 Mixed Methods Research Design

Sequential Designs

Concurrent Designs

The Study – Sequential Exploratory Strategy

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Sampling

Approaches

Techniques

The Study – Case Study and Survey

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The Study – Pattern Match and SEM

6.5 Methodological Soundness

Reliability

Validity

Generalisability

The Study – Mixed Methods Research

6.6 Conclusion

6.0 INTRODUCTION

This chapter aims to discuss the research methodology, and to outline the research design and method employed in this study. Section 6.1 first discusses the philosophical assumptions and how the research orientations are shaped. This section concludes by discussing the philosophical base the researcher holds and the suggested research approach in this study. Section 6.2 details the research design and concludes by presenting the suggested research design for this study. Section 6.3 reviews the data collection process in regard to the access and ethical issues, sampling, data collection approaches and techniques; it concludes with the appropriate ones for this study. Section 6.4 discusses the data analysis in regard to processing data, analysing data, and interpretation, and it concludes with the appropriate approaches for this study. Section 6.5 reviews methodological soundness; it concludes by discussing how the methodological soundness is achieved in the present research project. Finally, the chapter concludes by summarising the employed research design and methods in this study.

6.1 PHILOSOPHICAL STANCE

The philosophical stance can be viewed as 'a basic set of beliefs that guide action' (Guba 1990, p.17) and it underlies the research design (Easterby-Smith, Thorpe and Lowe 2002). Scholars may term it differently, such as epistemologies and ontologies (Crotty 1998), paradigms (Lincoln & Guba 2000; Mertens 1998), or worldview (Creswell 2005). Philosophical assumptions remain largely hidden in research; they influence the practice of research and need to be identified (Slife & Williams 1995; Creswell 2009).

Philosophical Assumptions

Burrell and Morgan (1994) suggest conceptualising social science in terms of four sets of philosophical assumptions related to ontology, epistemology, human nature and methodology. Each set of assumptions entails the strands of debate.

Ontological assumptions concerns whether the 'reality' to be investigated is of an 'objective' nature or the product of individual cognition. In other words, it is the question of whether 'reality' is a given 'out there' in the world or the product of one's mind? There have been much discussion in the literature and there are areas of controversy surrounding them (e.g. Kolakowski 1972; Keat and Urry 1975; Guba and Lincoln 2005). The 'nominalist' position revolves around the viewpoints that the social world external to individual cognition is made up of nothing more than names, concepts and labels which are merely used to structure reality (Kolakowski 1972). 'Realism', on the other hand, postulates that the social world external to individual cognition is a real world made up of hard, tangible and relatively immutable structure. For the realist, the social world has an existence which is as hard and concrete as the natural world. Whether or not we label and perceive these structures, the realists maintain, they still exist as empirical entities (Keat and Urry 1975).

Epistemological assumptions are about the grounds of knowledge – about how one might begin to understand the world and communicate this as knowledge to others. These views entails ideas about what forms of knowledge can be obtained, and how one can sort out what is to be regarded as 'true' form and what is to be regarded as 'false'. The debate lies in the 'positivist' and the 'anti-positivist' views (Burrel and Morgan 1994). The positivist epistemology seeks to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements (Comte 1853). The grounds of knowledge lie in a cumulative process in which new insights are added to the existing stock of knowledge and false hypotheses eliminated (Easterby-Smith et al. 2002). The anti-positivism firmly sets against the utility of a search for laws or underlying regularities in the world of social affairs. Anti-positivism rejects the standpoint of the objective 'observer', which characterises positivist epistemology as a valid advantage point for understanding human activities. Instead, anti-positivism holds that one has to understand from the inside rather than the outside. From this point of view social science is seen by anti-positivism as been essentially a subjective rather than an objective (as positivists' view) enterprise (Glaser and Strauss 1967). In this

sense, anti-positivism tends to reject the notion that science can generate objective knowledge of any kind.

Associated with the ontological and epistemological issues is a third set of assumptions concerning 'human nature' and, in particular, the relationship between human beings and their environments. Researchers entail a view of human beings responding in a mechanistic or deterministic fashion to the situations encountered in their external world. This perspective can be contrasted with man is regarded as the controller as opposed to the controlled of his environment. A 'determinist' view concerns human being and his/her activities as being determined by the situation or 'environment' in which he/she is located; and the 'voluntarist' view that man is autonomous and free-willed (Burrel and Morgan 1994). Such assumptions are essential elements in social science, since they define in broad terms the nature of the relationships between mankind and the society in which he/she lives (Burrel and Morgan 1994).

Different ontologies, epistemologies and models of human nature are likely to incline social scientist towards different methodologies in which social world has been viewed differently. It is possible, for example, to identify methodologies employed in social science research which treat the social world like the natural world, as being hard, real and external to the individual, and others which view it as being of a much softer, personal and more subjective quality. If one subscribes to a view of the former kind, then the scientific endeavour is likely to focus upon an analysis of relationships and regularities between the various elements which it comprises. If one subscribes to the alternative view of social reality, then the research focuses on explanation and understanding of what is unique and particular to the individual rather than of what is general and universal. Burrel and Morgan (1994) distinguish an 'ideographic from 'nomothetic' approach. The ideographic approach is based on the view that one can only understand the social world by obtaining first-hand knowledge of the subject under investigation. The ideographic method stresses the importance of letting one's subject unfold its nature and characteristics during the process of investigation. The nomothetic approach, on the other hand, emphasises

the importance of basing research upon systematic protocol and technique, which focus upon the process of testing hypotheses in accordance with the scientific rigour (Burrel and Morgan 1994).

Figure 6.1 summarises these philosophical assumptions about the nature of social science:

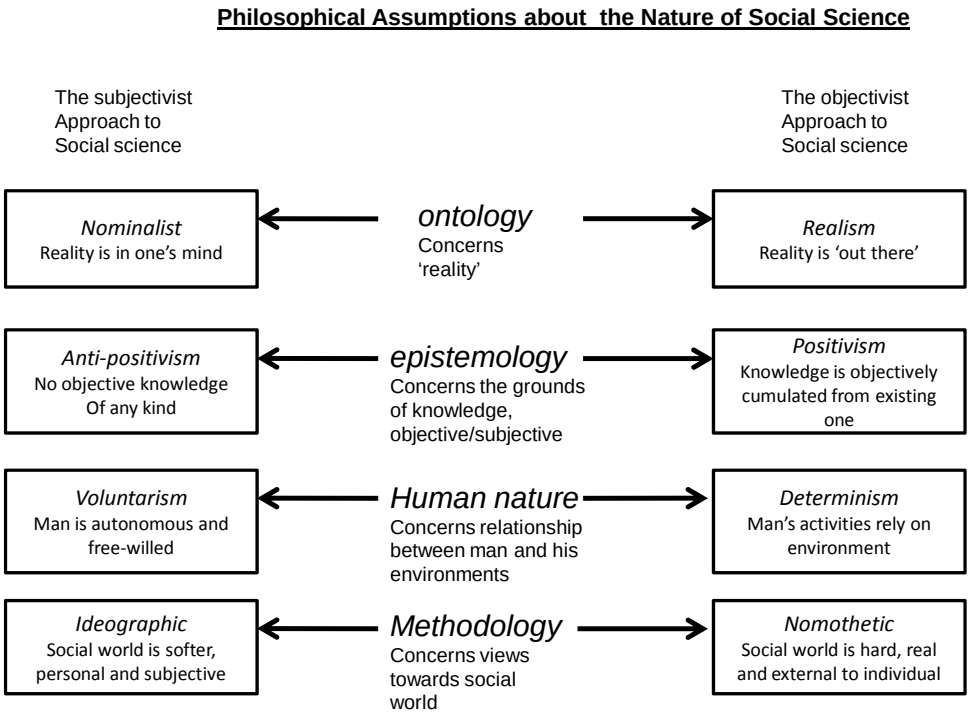


Figure 6.1: Philosophical Assumptions (Source: Burrel and Morgan 1994)

Shaping Research Orientation

In studying the connection between philosophical viewpoints and doing research, Creswell (2003) see philosophical assumptions as general orientations about the world and the nature of research that the researcher holds (p.6). These assumptions are shaped by the discipline area of the researcher, the beliefs of faculty in a studied area, and researcher's past research experiences. Four different views are identified: post-positivism, constructivism, advocacy/participatory, and pragmatism (Creswell 2003). Post-positivists represents the thinking after positivism, challenging the

traditional notion of the absolute truth of knowledge and recognising that we cannot be 'positive' about our claims of knowledge when studying the behaviour and actions of humans. Post-positivists hold a deterministic philosophy in which causes determine effects. Thus, this group of researchers tends to identify failures to reject the hypothesis (Smith 1983; Phillips and Burbules 2000). In this sense, research is the process of theory verification. The post-positivist assumptions have represented the traditional form of research, and these assumptions hold true more for quantitative research (Creswell 2009). For example, most quantitative research starts with the test of a theory, and in quantitative studies, researchers advance the relationship among variables and pose this in terms of questions or hypotheses (Phillips and Burbules 2000).

The social constructivists, on the other hand, hold assumptions that individuals seek understanding of the world in which they live and work (Berger and Luekmann 1967; Crotty 1998). Individuals develop subjective meanings of their experiences. The goal of the research relies on the participant's view of the situation being studied (Lincoln and Guba 2000; Schwandt 2007). Rather than starting a theory (as in post-positivism), researchers generate or inductively develop a theory or pattern of meanings (Crotty 1998). Social constructivism is typically seen as an approach to qualitative research. In discussing constructivism, Crotty (1998) identified several assumptions. First, meanings are constructed by human beings as they engage with the world they are interpreting. Qualitative researchers tend to use open-ended questions so that the participants can share their views. Second, humans engage with their world and make sense of it based on their historical and social perspectives. Thus, qualitative researchers seek to understand the context or setting of the participants through visiting this context and gathering information personally. They interpret what they find, an interpretation shaped by the researcher's own experience and background. Finally, the basic generation of meaning is always social, arising in and out of interaction with a human community. The process of qualitative research thus is largely inductive, with the researcher generating meaning from the data collected in the field.

Another group of researchers holds to the philosophical assumptions of the advocacy/participatory approach. This view arose during the 1980s and 1990s from individuals who felt that the post-positivist assumptions imposed structural laws and theories that did not fit marginalised individuals (e.g. policy makers) in our society, nor did the constructivist view go far enough in advocating for an action agenda to help marginalised peoples (Fay 1987; Kemmis and Wilkinson 1998). An advocacy/participatory view holds that research inquiry needs to be intertwined with politics and a political agenda. Participatory action is collaborative and dialectical, focusing on bringing about change in practices. Thus, researchers advance an action agenda for change (Kemmis and Wilkinson 1998). The advocacy/participatory view is typically seen with qualitative research, but it can be a foundation for quantitative research as well (Neuman 2000; Kemmis and Wilkinson 1998; Creswell 2003). The key here is, for advocacy/participatory researchers, there is undoubtedly a strong stimulus to pursue topics that are of personal interest – issues that relate to marginalised people and an interest in creating a better society (Creswell 2009).

Another position comes from the pragmatists. Pragmatism arises out of actions, situations, and consequences rather than antecedent conditions (as in post-positivism). There is a concern with applications – what works – and solutions to problems (Patton 1988; Cherryholmes 1992). Researchers emphasise the research problem and use all approaches available to understand the problem (Rossman & Wilson 1985). Pragmatism provides a philosophical basis for research. First, pragmatism is not committed to any one system of philosophy and reality. Individual researchers make the choice based on the research problem. In this way, researchers are able to choose the methods, techniques, and procedures of research that best meet their needs and purposes (Tashakkori and Teddlie 1998). This applies to mixed methods research in that researchers draw from both quantitative and qualitative approaches that fit into the studies they engage. Further, pragmatists do not see the world as an absolute unite. Truth is what works at the time. Pragmatists have believed in an external world independent of the mind as well as that lodged in the mind (Cherryholmes 1992). The pragmatist researchers look to the 'what' and 'how' to research, based on the intended consequences – where the appropriateness

lies in (Rossman & Wilson 1985; Patton 1988; Tashakkori and Teddlie 1998; Morgan 2007; Creswell 2009). Thus, in mixed methods research, researchers use both quantitative and qualitative data because they work to provide the best understanding of a research problem. Finally, pragmatism opens the door to multiple methods, different philosophical bases and assumptions, as well as different forms of data collection and analysis (Morgan 2007; Creswell 2009).

Table 6.1 summarises four philosophical bases and their research orientation:

Four Philosophical Bases and the Research Orientation

Post-positivism -Determination -Reductionism -Empirical observation and measurement -Theory verification	*Constructivism* -Understanding -Multiple participant meanings - social and historical construction -Theory generation
Advocacy/Participatory -Political -Empowerment issue-oriented -Collaborative -Change-oriented	*Pragmatism* -Consequences of actions -Problem-centred -Pluralistic -Real-world practice oriented

Table 6.1: Philosophical Bases and Research Orientation (Source: Creswell 2003)

The Study – Pragmatism and Mixed Methods Research

The purpose of this study is to explore how firms learn about NPD in their business networks by investigating empirical phenomena, proposing a theoretical model, and examining the proposed theoretical model with large sample. Based on the purpose and the objectives of the study, a 'pragmatist' view is adopted, in which using the mix-methods research to propose and examine theory is deemed as the most appropriate approach. This section presents the rationale of adopting this view and explains the mixed methods approach employed in this study.

Rationale

In seeking better understanding of the research problem, the present study attempts to explore participants' (i.e. new product developers) views with the intent of building theories based on these views, and with the aim of examining the proposed theories with a large sample of population. 'Pragmatism' allows the researcher to employ the appropriate research approach to best meet the needs and purposes of the present research. First, as discussed in the previous chapter, this study departs from that we know so little about how firms learn about NPD in their business networks. To gain insights and ideas on the research topic, an exploratory research by collecting qualitative data has been view the most appropriate (Churchill and Iacobucci 2005). The qualitative approach helps the researcher to clarify concepts in the study: *'Is the learning mechanism suggested by the literature the one used by firms in their successful NPD?' 'Is there a more appropriate learning model that describes better for how firms learn about NPD in their business networks?* The qualitative approach helps to gather knowledge about theses research problems and identify variables and constructs. Propositions and theories are then developed based on the identified variable and constructs.

From the pragmatist view, qualitative method research works better to provide the best understanding of the research question at the first stage. However, how far are the proposed propositions and theories close to the 'truth'? To examine the emergent theory proposed in the qualitative study, a qualitative approach is deemed appropriate (Croswell 2009; Easterby-Smith 2002). This study intends to test the NPD network learning model suggested by the qualitative study as well as to test the impact of the proposed learning model on NPD uncertainty and time reduction in a large scale sample. A research by quantitative method thus works better in examining propositions at the second stage.

In sum, in dealing with the complex research as the present study, pragmatism allows the researcher to utilise an appropriate research approach to better meet the research aim and objectives. This need cannot be satisfied by post-positivism,

constructivism, or participatory. Based on this philosophical base, a research by mixed methods approach is practical to the researcher who not only intends to explore the phenomena in NPD network learning but also intends to examine the qualitative findings. It is thus regarded as the most appropriate approach to explore and gain a better understanding on the research problem in this study – how firms learn about NPD in their business networks.

6.2 MIXED METHODS RESEARCH DESIGN

Several authors have developed typologies of mixed methods research designs (e.g. Greene et al. 1989; Morse 1991; Creswell 2003). Creswell et al. (2003) developed a system for classifying mixed methods research designs. There are six types of designs: three sequential (explanatory, exploratory, and transformative) and three concurrent (triangulation, nested, and transformative). Each varies with respect to (a) its approach to implementation (sequential or concurrent data collection procedures), (b) priority given to the quantitative and qualitative data (equal or unequal), (c) stage at which the data are analysed and integrated (separated, transformed, or connected), and (d) procedural notations.

Sequential Designs

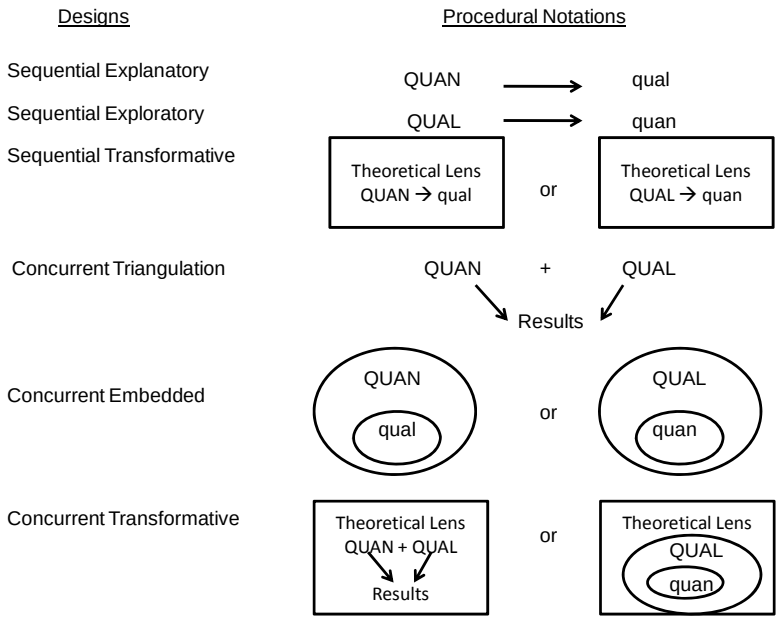
There are three types of sequential designs: sequential explanatory, sequential exploratory and sequential transformative. In sequential explanatory designs, quantitative data are collected and analysed, followed by qualitative data. Priority is usually given to the quantitative data. Data analysis is usually connected and integration usually occurs at the data interpretation stage and in the discussion. These designs are usual for, as its name suggests, explaining relationships and/or study findings, especially when they are unexpected (Morse 1991). In sequential exploratory designs, qualitative data are collected and analysed first, followed by quantitative data. Priority is usually given to the qualitative data. Quantitative data are used primarily to augment qualitative data. Same as the sequential explanatory designs, data analysis is usually connected, and integration usually occurs at the data interpretation stage and in the discussion. These designs are useful for exploring

relationships when study variables are not known, refining and testing an emerging theory, developing new test/assessment instruments (or models) based on an initial qualitative analysis, and generalising qualitative findings to a specific population (Morgan 1998). In sequential transformative designs, quantitative data may be collected and analysed, followed by qualitative data, or conversely, qualitative data may be collected and analysed, followed by quantitative data. The priority can be given to either or distributed evenly to both type of data. Unlike the sequential exploratory and explanatory approaches, the sequential transformative model has a theoretical perspective (e.g. gender, race, social science theory) to guide the study. Data analysis is usually connected and integration usually occurs at the data interpretation stage and in the discussion. These designs are useful for giving voice to diverse or alternative perspectives, advocating for research participants, and better understanding a phenomenon that may be changing as a result of being studied (Hanson et al 2005).

Concurrent Designs

Similar to sequential mixed methods research designs, there are three types of concurrent designs: Current triangulation, concurrent nested, and concurrent transformative. In concurrent triangulation designs, quantitative and qualitative data are collected and analysed at the same time. Priority is usually equal and given to both forms of data. Data analysis is usually separate, and integration usually occurs at the data interpretation stage. Interpretation typically involves discussing the extent to which the data triangulate or converge. These designs are useful for attempting to confirm, cross-validate, and corroborate study findings (Greene, et al. 1989; Morgan 1998). In concurrent nested designs, like concurrent triangulation designs, quantitative and qualitative data are collected and analysed at the same time. However, priority is usually unequal and given to one of the two forms of data – either to the quantitative or qualitative data. The nested (or embedded) forms of data are, in these designs, usually given less priority. One reason for this is that the less prioritised form of data may be included to help answer an altogether different question or set of questions. Data analysis usually involves transforming the data, and integration usually occurs during the data analysis stage. These designs are

useful for gaining a broader perspective on the research topic and for studying different groups, or levels, within a single study (Tashakkori and Teddlie 1998). Finally, in concurrent transformative designs, quantitative and qualitative data are collected and analysed at the same time. Priority may be unequal or equal to both forms of data. Data analysis is usually separate, and integration usually occurs at the data interpretation stage or, if transformed, during data analysis. In contrast to the other two concurrent designs, concurrent transformative designs use an explicit theoretical lens (e.g. feminist perspectives, critical theory). Similar to sequential transformative design, these designs are useful for giving voice to diverse or alternative perspectives, advocating for research participants, and better understanding a phenomenon that may be changing as a result of being studied (Hanson et al. 2005). Figure 6.2 illustrates the six types of mixed methods research designs:



Note: QUAN = quantitative data is prioritised; QUAL = qualitative data is prioritised.
qual = lower priority given to the qualitative data; quan = lower priority given to the quantitative data.

Figure 6.2: Mixed Methods Research Designs (Source: Creswell et al. 2003; Hanson et al. 2005)

The Study – Sequential Exploratory Strategy

In considering the purpose of the research and the research questions, this study adopts the sequential exploratory strategy that qualitative data will be collected and analysed first, followed by quantitative data (Creswell et al. 2003). The integration

occurs at the data interpretation stage and in the discussion. The research project involves a four-phase approach. The researcher first gathers qualitative data in addressing the research questions (1) what is the business network learning process in successful NPD? And (2) how do firms engage with their alliances that construct the business network learning process found in question (1)? The researcher gathers and analyses qualitative data (Phase 1). A NPD network learning model and hypotheses will be proposed from the emergent theory drawn from the qualitative data analysis (phase 2). The researcher then tests the proposed NPD network learning model and its impact on NPD uncertainty reduction and speed-to-market (phase 3). Data interpretation and discussion are followed by integrating findings and results from previous three phases (Phase 4). The sequential exploratory strategy provides several advantages to the present study. First, its phased approach (qualitative approach followed by theory building and quantitative approach) makes it easy to implement and straightforward to describe and report. Second, the sequential exploratory strategy is helpful for exploring relationships when study variables (e.g. NPD network learning process, firm's engagements) are unknown. Finally, the sequential exploratory strategy is especially advantageous to help the researcher not only to explore and under-research area (i.e. NPD network learning) through qualitative study but also to examine the understanding through quantitative approach.

6.3 DATA COLLECTION

All research involves the collection and analysis of data, whether through reading, observation, measurement, asking questions, or a combination of these or other strategies. The distinction between deskwork and fieldwork offers an alternative way of thinking about basic data collection strategies. Fieldwork refers to the process of going out to collect research data. Such data may be described as original or empirical, and cannot be accessed without the researcher engaging in some kind of expedition. Deskwork, on the other hand, consists of those research processes which do not necessitate going into the field. Literally, of those things which can be done while sitting at a desk. Fieldwork-deskwork may be a false dichotomy, since most

research projects make use of both set of approaches (Blaxter et al. 2006). The opportunities and preference for either fieldwork or deskwork help researchers in choosing the kinds of methods that are used. The data collected during and for research may, however, vary considerably in their characteristics. It depends on the data collection decisions a researcher makes. This section discusses the data collection in regard to its access and ethical issues, sampling, approaches, and techniques. It concludes by summarising the present research project's approaches.

Access and Ethical Issues

As soon as a researcher begins to consider collecting data for a research project, two key issues are likely to confront him/her: access and ethics. These issues are a continuing concern throughout the process of data collection. They have to do with what information the researcher is able to collect, how the researcher gets it and how the researcher uses it. As researchers anticipate data collection, they need to respect the participants and the sites for research. Blaxter et al. (2001) suggest a researcher to consider five major issues before seeking access for data collection. (1) Who or what does a researcher want to research? (2) Who are the key individuals, or gatekeepers that a research needs to get permission from? (3) How much commitment will a researcher require for the research from his/her subjects in terms of hours, days, weeks or months? (4) Is this reasonable? (5) Can he/she identify any potential problems with regard to access? In addition to the access issues, researchers need to anticipate the ethical issues that may arise during their studies (Hess-Bieber and Leavey 2006). Four common ethical issues can be expected in a research project (Blaxter et al. 2001). The first issue is 'confidentiality': in cases where confidentiality has been agreed or demanded, researchers have to use collected material in the agreed way. Ignorance to it could threaten the sources and undermine the whole research project. The second issue concerns 'anonymity': this is often linked to the issue of confidentiality. Where researchers have assured individuals or organisations that they will not be identifiable in the report or theses, careful consideration may need to be given to how to disguise them. The third issue regards to 'legality': this issue could also be seen as an obligation shared by all citizens. It is

a researcher's duty to report any illegal activities of which he/she becomes aware in the course of the research. Final issue is 'professionalism': if a researcher is a member of a professional group, this imposes or assumes certain standards of conduct in the professional life.

Sampling

While most people would associate the words 'sampling' with survey approaches, there will be elements of these involved, and whatever approach is taken in a research project. For example, if a research involves observation, it is impossible to observe everyone of interest all the time. If a research carrying out a case study, to select the focused case(s) is needed. Sampling thus is important in data collection in all research projects. There are a wide variety of sampling strategies available for use. They can be divided into two main groups, probability and non-probability sampling (Blaxter et al. 2001). The most widely understood probability sampling approach is probably random sampling, where every individual or object in the population of interest has equal chance of being chosen for study. Non-probability sampling approaches are used when the researcher lacks a sampling frame for the population in question, or where a probabilistic approach is not necessary. The following summarises the options of sampling strategies *(Blaxter et al. 2006):*

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Probability Sampling:

-Simple random sampling: selection at random.

-Systematic sampling: selecting every *n*th case.

-Stratified sampling: sampling within groups of the population.

-Cluster sampling: surveying whole clusters of the population sampled at random.

-Stage sampling: sampling clusters sampled at random.

Non-probability Sampling:

-Convenience sampling: sampling those most convenient.

-Voluntary sampling: the sample is self-selected.

-Quota sampling: convenience sampling within groups of the population.

-Purposive sampling: handpicking supposedly typical or interesting cases.
-Dimensional sampling: multidimensional quota sampling.
-Snowball sampling: building up a sample through informants.

Quantitative data often involve random sampling so that each individual has an equal probability of being selected, and the sample can be generalised to the larger population. In qualitative data collection, purposeful sampling is often used so that individuals are selected because they have experienced the central phenomenon. Rigorous sampling procedures need to be conveyed. In mixed method research, Teddlie and Yu (2007) have developed a typology of five types of mixed methods sampling. First, 'basic strategies' that involve combining quantitative and qualitative sampling (e.g. stratified purposeful sampling, purposive random sampling). Second, 'sequential sampling', in which the sampling from the first phase or strand informs the second phase or strand. Third, 'concurrent sampling', in which quantitative probability and qualitative purposeful sampling are combined as independent sampling procedures or jointly (e.g. a survey with both closed-ended and open-ended responses). Fourth, 'multilevel sampling': in which sampling occurs in two or more levels or units of analysis. Fifth: sampling using any combination of the foregoing strategies. It is important to identify the sampling strategies and approaches used to establish validity of the data. It is also helpful to understand the specific types of data to be collected.

Approaches

Before adopting any method of data collection, it helps to be clear about the overall objectives of the research. This applies to the choice of the approaches and techniques of collecting data. This section discusses four basic approaches to research in the social sciences: action research, case studies, experiments and surveys. This classification is not meant to be either definitive or exclusive. It simply recognises the most common approaches used in doing social sciences research (Blaxter et al. 2006).

Action research

Action research is a complex, dynamic activity involving the best efforts of both members of communities or organisations and professional researchers (Greenwood and Levin 1998, p50). Action research is an increasingly popular approach among researchers in the social sciences. It is well suited to the needs of people conducting research in their workplaces, and who have a focus on improving aspects of their own and their colleagues' practices. It lends itself to the direct involvement and collaboration of those whom it is designed to benefit (Costello 2003). Hart and Bond (1995) suggest some to distinguish action research from other research approaches: (1) action research is educative; (2) it deals with individuals as members of social groups; (3) it is problem-focused, context-specific and future-oriented; (4) it involves a change intervention; (5) it aims at improvement and involvement; (6) it involves a cyclic process in which research, action and evaluation are interlinked; and (7) it is founded on a research relationship in which those involved are participants in the change process. The purpose of action research is, always and explicitly, to improve practice. That said, action research is a way of producing tangible and desired results for the people involved, and it is a knowledge-generation process that produces insights both for researchers and the participants (Greenwood and Levin 1998; Griffiths 1998). Rappoport (1970) explained well:

'Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually accepted ethical framework.' (Rappoport 1970: 499)

Action research is useful when dealing with problem-focused, context-specific and future-oriented projects. Action research aims at improvement and involvement and is educative. Action research aims at having a direct and immediate impact; and hence it is accepted that change should be incorporated into the research process itself. Nevertheless, action research works ineffectively to drive an unpopular policy or initiative through or to try to bring a dysfunctional team or workgroup together. Also it is inappropriate uses of action research to experiment with different solutions without thinking through carefully their soundness (*Easterby-Smith et al. 2002).*

Finally, action research focuses more on what happens next; it is weaker on formal account of research findings.

Case Study

Case study is the method of choice when the phenomenon under study is not readily distinguishable from its context. That said, case study can be the preferred strategy when 'how' or 'why' questions are being posed, when the researcher has little control over events, and when the focus is on a contemporary phenomenon within some real-life context (Yin 2003). Case study can be characterised by researchers spending extended time on site, personally in contact with activities and operations of the case, reflecting, and revising descriptions and meanings of what is going on (Stake 2005). The case study researcher typically observes the characteristics of an individual unit – a child, a class, or a company. The purpose of such observation is to probe deeply and to analyse intensively the multifarious phenomena that constitute the life cycle of the unit with a view to establishing generalisations about the wider population to which that unit belongs (Cohen et al. 2000). Yin (2003) identifies six types of case study, defined along two dimensions: (1) in terms of the number of cases: single or multiple; (2) in terms of the purpose of the study: exploratory, descriptive, or explanatory.

A primary distinction in designing case studies is between single- and multiple-case designs. It is suggested that when a researcher has the choice, multiple-case designs may be preferred over single-case designs (Yin 2003). First, analytic conclusions independently arising from two (or more) cases will be more powerful than those coming from a single case. Further, the contexts of the two cases are likely to differ to some extent. If under these varied circumstances, common conclusions can still be arrived, they will have immeasurably expanded the external generalisability of the findings compared to those from a single case alone. There are at least three different applications in conducting case study. Exploratory case study: can be used to explore those situations in which the intervention being evaluated has no clear. Descriptive case study can be applied to describe an intervention and the real-life context in which it occurred. And explanatory case study is applied to explain the

presumed causal links in real-life interventions that are too complex for the survey or experimental approaches. The case study relies on techniques as direct observation of the events being studied and interviews of the persons involved in the events, and it has its own pros and cons.

Case study data are drawn from people's experiences and practices and so are said to be strong in reality. Case studies (specifically, multiple-case study) allow for generalisations from a specific instance to a more general issue. Case studies allow the researcher to show the complexity of social life. Good case studies build on this to explore alternative meanings and interpretations. Case studies can provide a data source from which further analysis can be made. They, can, therefore, be archived for further research work. Because case studies build on actual practices and experiences, researchers can be linked to action and their insights contribute to changing practice. Indeed, case study may be a subset of a broader action research project. Because the data contained in case studies are close to people's experiences, they can be more persuasive and more accessible.

Researchers, on the other hand, need to be aware of shortcomings of using case study as research approach. First, the very complexity of a case can make analysis difficult. This is particularly so because the holistic nature of case study means that the researcher is often very aware of the connections between various events, variables and outcomes. To show the connections but not lose sight of the whole could be a challenge in case study. Further, while the contextualisation of aspects of the case strengthen this form of research, it is difficult to know where 'context' begins and ends (*Cohen et al 2000; Yin 2003).*

Experiments

The experiment is a situation in which the independent variable is carefully manipulated by the researcher under known, tightly defined and controlled conditions or by nature occurrence (Bowling 2002). An experiment tests cause-and-effect relationships in which the researcher randomly assigns subjects to groups. It is often reminded for more caution in the use of experiments as a research approach in

the social sciences (Bowling 2002). Since the social sciences are concerned with human behaviour and perspectives, a strict application of an experimental approach to research in these areas would suggest exposing one group of individuals to the experiment. There are, in other words, ethical issues around the use of experiments involving people.

Researchers choose experiment as the research approach for several reasons. First, because of the assignment of people to intervention and control (i.e. randomisation of extraneous variables) the risk of extraneous variables confounding the results is minimised. Further, because experiment controls over the variation of the 'predictor' variables, it clarifies the direction of cause and effect. The modern design of experiment permits greater flexibility, efficiency and powerful statistical manipulation. Doing experiments also has several issues. For example, it is difficult to design experiments so as to represent a specified population, and it is often difficult to choose the 'control' variables so as to exclude all confounding variables. Further, with a large number of uncontrolled, extraneous variables it is impossible to isolate the one variable that is hypothesised as the cause of the other; hence the possibility always exists of alternative explanations. Contriving the desired 'natural setting' in experiments is often not possible. Finally, the experiment is an unnatural social situation with a differentiation of roles. The participant's role involves obedience to the experimenter (an unusual role). The experiment cannot capture the diversity of goals, objectives and service inputs which may contribute to outcomes in natural setting (*Bowling 2002)*

Survey

A survey design provides a quantitative or numeric description of some fraction of the population – the sample – through the data collection process of asking questions (Fowler 1988; Creswell 1994). From sample results, the researcher generalises or makes claims about the population. These data collections, in turn, enabled a researcher to generalise the findings from a sample of responses to a population. The simplest form of sample in a survey is the random sample. Here every 'unit' of the population has an equal chance of being selected as the sample. When conducting a

survey research, sample size affects all results (Hair et al. 1998). The size of the survey sample has the substantial impact in achieving statistical significance. A reasonable sample size is suggested to be at least 200 usable respondents (Hair et al. 1998).

Using survey has several merits. Questions were designed so that collected data can be added together to produce results which apply to the whole sample. The questions are designed to be unbiased. Survey results served future replication. Large survey can often be broken down. Nevertheless, survey research has its own issues. For example, the data become the main focus of the research report, which could lead to a loss of linkages to wider theories and issues. The data provide snapshots of points in time rather than a focus on the underlying process and changes. The researcher may lack the position to check firsthand the understandings of the respondents to the questions asked. Accuracy and truthfulness may become issues. The survey relies on breadth rather than depth for its validity. This is a crucial issue for small-scale researches (*Hutton 1990)*.

Techniques

As discussed earlier, the distinction between deskwork and fieldwork offers an alternative way of thinking about basic data collection techniques. Four main techniques (or methods) for producing data are identified and discussed in this section: documents, interviews, observation, and questionnaires.

Documents

All, or virtually all, research projects involve the use and analysis of documents. Researchers are expected to read, understand and critically analyse the writings of others, whether fellow researchers, practitioners or policy-makers. For example, they might be library-based, aimed at producing a critical synopsis of an existing area of research writing; might be computer-based, consisting largely of the analysis of previously collected data sets; might be work-based, drawing on materials produced within an organisation; might have a policy focus, examining materials

relevant to a particular set of policy decisions; or might have a historical orientation, making use of available archival and other surviving documentary evidence (Mason 1999; Nixon 2000; Payne et al. 2004). Researchers who base their studies on documents may make considerable use of secondary data; that is, data which has already been collected and possible also analysed, by somebody else.

Interviews

The interview method involves questioning or discussing issues with people. It can be a very useful technique for collecting data which would likely not be accessible using techniques such as observation or questionnaires. Many variations on the interview method are possible. For example, interviews may take place face-to-face or at a distance. The interview may be tightly structured, with a set of questions requiring specific answers, or it may be very open, taking the form of a discussion. Different forms of questioning may be practiced during the interview, such as classroom, courtroom and clinical questioning (Dillon 1990). Of particular note is the growth of the Internet and focus group interviews. For example, through email, the Internet offers a relatively cheap way of conducting interviews at a distance. Focus groups offer the opportunity to interview a number of people at the same time, and to use the interaction between groups as a source of further insight (Easterby-Smith et al. 2002).

Observations

The observation method involves the researcher in watching, recording, and analysing events of interest. A range of different approaches are possible in observation studies (Hallowell et al. 2005). For example, the events may be recorded, either at the time or subsequently, by the researcher, or they may be recorded mechanically. The observation may be structured in terms of a predetermined framework, or may be relatively open. The observer may also be a participant in the events being studied, or may act solely as a 'disinterested' observer. Observations may be made either in the field or in the lab. The lab allows greater control of extraneous influences and thus may be more internally valid (i.e. correct inference), although less externally valid (i.e. generalisability). The field study may

be a completely natural setting or may be induced by an experimental manipulation. One of popular forms of field observation is the 'ethnography'. Ethnographic methods are increasingly being used by researchers as another example of an in-depth case approach to develop insights (Churchill and Iacobucci 2005). These procedures involve the prolonged observation of sample's behaviours, emotional responses, and cognitions during their ordinary daily lives.

Questionnaire

Questionnaires are one of the most widely used social research techniques. There are a number of different ways in which questionnaires can be administered. They can be sent by post to the intended respondents, who are then expected to complete and return them themselves. They can be administered over the telephone or face-to-face, in the latter case becoming much like a highly structured interview. They can also be sent over and complete over the Internet. Each of these methods has advantages and disadvantages. Face-to-face surveys may get a better response rate, but are more time consuming for the researcher. Postal and email surveys are likely to have lower response rates, and possible poorer answers because the respondent has no one available to answer any queries; but they may allow a larger number of people to be surveyed. There are a variety of ways in which questions can be asked: quantity or information, category, list or multiple choice, scale, ranking, complex grid or table, and open-ended (Simnett and Wright 2005).

The Study – Case Study and Survey

In this mixed methods research, both qualitative and quantitative data are collected. In addressing the access and ethics issues, the codes of ethics are observed. Protocols (see appendix) are prepared before data were collected, in which the issues of who and what does the researcher want to research, and the issues of confidentiality, and anonymity are specified. In terms of sampling, the present research project concerns network learning in successful NPD projects, the samples are selected purposively from companies that have successful NPD experience. In collecting qualitative data, it was well acknowledged that finding research samples is

a big challenge in studying business networks (Håkansson and Johnson 2001). The researcher chooses the snowball sampling strategy for it helps easier to build up the sample through informants in the business network arena. As to quantitative data collection, simple random sampling is employed, where every individual in the population of interest (companies that have successful NPD experience) has equal chance of being chosen for study. Thus, purposive and snowball sampling strategies (Blaxter et al. 2006) are employed for qualitative data collection; and random sampling strategy is adopted for quantitative data collection.

In regard to the research approach, an exploratory multiple-case study is employed to investigate empirical phenomena; and in testing the propositions proposed by the case study results, large scale survey research is used. Action research and experiment approach are rejected. Action research is strong in dealing with problem-solution type of research and is strong in dealing with future-oriented projects (Blaxter et al. 2006). The present research project, instead of solving problems or looking for future action correction, seeks to understand an under-researched phenomenon. Action research hence is deemed inappropriate for this research project. Experiment is strong in dealing with testing cause-and-effect relationships by manipulation of variables. The approach of experiments is rejected for that no manipulation of any variables is intended in this research project. In collecting qualitative data, the exploratory case study has its most notorious reputation in that qualitative data collection is undertaken prior to the final definition of study propositions (Yin 2003). The goal may justifiably be a discover theory by directly observing a social phenomenon in its raw form (Glaser and Strauss 1967). Therefore, an exploratory multiple-case study approach is employed in collecting qualitative data for this study. In collecting quantitative data, random sample survey enables the researcher to generalise the findings from a sample of responses to population, and is chose as the most appropriate approach in examine hypotheses generated from the multiple-case study.

As to the data collection techniques, depth interview is selected as a main technique combining the techniques of observation and documents to collect qualitative data in

this study. The depth interview facilities the researcher to build rapport quickly by proceeding through a set of guided open-end questions, allowing the researcher to tap insights of selected samples. The methods of observation and documents provide further assistance to both complement to and verify the collected data. Questionnaire is employed for quantitative data collection in that it formulates precise written questions, for those whose opinions or experience the researcher is interested in (i.e. firms with successful NPD projects), and to find the answers to the issues that interest the study.

In sum, in this mixed-methods research, the exploratory multiple-case study by interview, observation, and documents is selected as the appropriate approach for collecting qualitative data; and the random sample survey by questionnaire is employed as the appropriate approach and technique for collecting quantitative data in this research project.

6.4 DATA ANALYSIS

Once data have been collected, the research process turns to analysis, which amounts to the search for meaning in the data (Churchill and Iacobucci 2005). This 'translation' and 'interpretation' of data into information and meaning involves many steps. Among different kinds of data a basic distinction between the quantitative (e.g. numbers) and the qualitative (e.g. words) can be recognised. This distinction has a major influence on how data may be analysed. This section first discusses qualitative and quantitative data processing, following by the respective data analysis; and the topic of interpretation. This section concludes by summarising how data is analysed in this study.

Processing Data

Data processing is a time-consuming, but necessary, step that leads to better prediction and more accurate assessment drawn from collected data. The objectives and scopes are different between processing qualitative data and processing

quantitative data. To reflect the different objectives better, the researcher employs the term 'management' for processing qualitative data and 'examination' for processing quantitative data.

Qualitative data management

A chronic problem of qualitative research is that it is done chiefly with words, not with numbers. Words are fatter than numbers and usually have multiple meanings (Miles and Huberman 1994). Managing qualitative data can be both the most difficult and the least codified part in the process (Eisenhardt 1989; Yin 2003). Qualitative data in their raw state do not constitute the results of the research. Researchers would be unlikely to simply bind together transcripts of all the interviews or of all the notes that have been taken, and present that as the report. That would be too long and too demanding for readers, and more importantly, it would lack insight and significance. The business of analysing the data that have been collected, first involves a process of data management. In managing data a closely related process is suggested: managing the data by reducing their size and scope, so that researchers can report upon them adequately and usefully. Miles and Humberman (1994) term this process 'data reduction' and 'data display'.

Four common techniques are used by many social science researchers: coding, annotating, labelling, and selection (Miles and Huberman 1994; Blaxter et al. 2001) Coding is the process by which items or groups of data are assigned codes. These may be used to simplify and standardise the data for analytical purposes. Annotating is the process by which written (or perhaps audio or visual) material is altered by the addition of notes or comments. The process may draw attention to what the researcher considers to be the more significant sections, perhaps for later abstraction and quotation. Labelling is where the researcher has an analytical scheme in mind (or is developing one) he/she may go through materials such as interviews or policy documents and label passages or statements with significant words.

Finally, selection is a key process in the management of data, through which interesting, significant, unusual or representative items are chosen to illustrate the

arguments. The processes of coding, annotating, labelling, and selection aim for proper data reduction and data display before analysing and interpreting data. Some software programs are available to help researchers for data management. For example, MAXqda helps researchers systematically evaluate and interpret qualitative texts. Atlas.ti enables a researcher to organise text, graphic, audio, and visual data files, along with coding, memos and findings, into a project. QSR NVivo features the popular software program N6 (or Nud.ist) and NVivo concept mapping and combination. Hyper RESEARCH is an easy-to-use qualitative software package enabling users to code, retrieve, build theories, and conduct analyses of the data. In sum, the data management process opts to produce a reduced version, précis or synposis of the whole qualitative data set, which is ready for further data analysis.

Quantitative data examination

Quantitative data examination concerns how to assess and overcome pitfalls resulting from the research design and data collection. In examining quantitative data, the evaluation of missing data, the identification of outliners, and the testing of the assumptions underlying most multivariate techniques are the most common processes before the researcher is confident to proceed data analysis (Hair et al. 1998). Missing data are a nuisance to researchers and may result from data entry errors or from the omission of answers by respondents. Outliers, or extreme responses, may unduly influence the outcome of any multivariate analysis. Finally, before applying any multivariate technique, the researcher must assess the fit of the sample data with the statistical assumptions underlying that multivariate technique. For example, researchers wishing to apply regression analysis would be particularly interested in assessing the assumptions of normality, linearity, and multicollinearity (Hair et al. 1998). Normality examines the data distribution for an individual variable and its correspondence to the normal distribution, the benchmark for statistical methods. An implicit assumption of all multivariate techniques based on correlational measures of association is linearity. Furthermore, the structural model will be problematic if the variables correlation (r =) is .90 or above, that is, prior to conducting the structural model, no multicollinearity ($r<0.9$) also needs to be ensured.

Today, software packages designed to carry out quantitative analysis are well established. One of the most widely available quantitative packages in social science is probably SPSS (Statistical Package for the Social Sciences). SPSS enables researchers to input raw data, to modify and re-organise them once they have been inputted, and to carry out a wide range of simple, statistical and multivariate analysis. Another widely used program is LISREL (Linear Structural RELations), a flexible model for a number of research situations (cross-sectional, experimental, quasi-experimental, and longitudinal studies). Some software packages allow researchers to examine data before conducing data analysis. For example, missing data happens in survey research when any systematic event external to the respondent (such as data entry errors or data collection problems) or action on the part of the respondent (such as refusal to answer) that leads to missing values (Hair et al. 1998). SPSS provides functions to replace missing data and check for significant differences between the datasets before and after the process. Checking 'outliers' is another common process in managing quantitative data. A function of 'Mahalanobis D^2 measure' provided by AMOS (provided by SPSS) allows the researcher to identify outliers.

Analysing Data

Analysis is about the search for explanation and understanding, in the course of which concepts and theories will likely be advanced, considered and developed. Data analysis is a rigorous process, using data that has been carefully collected, and managed (or examined). This process of translation of data into information and meaning is distinguished between qualitative and quantitative types of data.

Qualitative data analysis

Data analysis in qualitative method studies can be both difficult and un-codified process (Eisenhardt 1989; Yin 2003). The process of qualitative data analysis involves making sense out of text and image data. It is an ongoing process involving continual reflection about the data. All the collected 'raw' data were processed

before they are ready for use via transcription and editing. Data reduction played an important role in processing data. Data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming the 'raw' data (Miles and Huberman 1994). In other words, data reduction is a form of analysis that sharpens, sorts, focuses, discards, and organises data in such a way that 'final' conclusions can be drawn and verified. In data processing flows, data display appeared important and worked tightly with data reduction. Data display deals with an organised assembly of information that permits conclusion drawing and action taking. In the data processing model (Miles and Huberman 1994), data display together with data reduction helps to 'transform' raw data into meaningful information in searching answers to the research questions. Figure 6.3 illustrates the qualitative data processing model:

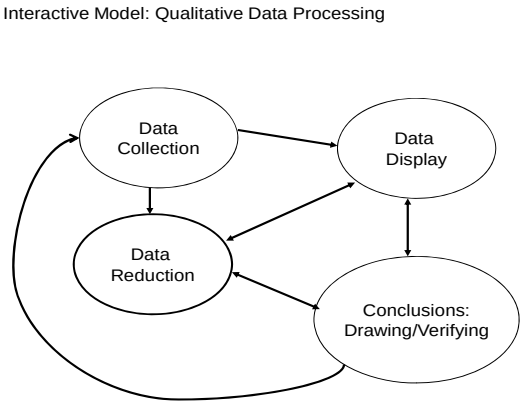


Figure 6.3: Qualitative Data Processing
(Source: Miles and Huberman's 1994)

Qualitative data analysis often is conducted concurrently with gathering data, making analysis, and writing reports (Rossman and Rallis 1998). In this approach, the researcher collects qualitative data, analyses it for themes or descriptions, and reports them. Today, many qualitative researchers go beyond this generic analysis to add a procedure within one of the qualitative strategies of inquiry. For example, 'grounded theory' has systematic steps (Corbin and Strauss 2007; Strauss and Corbin 1990). These involve generating categories of information (open coding), selecting one of the categories and positioning it within a theoretical model (axial coding), and then

explicating a story from the interconnection of these categories (selective coding). Case study and ethnographic research involve a detailed description of the setting, followed by analysis of the data for themes or issues (Yin 2003; Stake 1995). Narrative research employs re-storing the participants' stories the participants' stories using structural devices, such as plot, setting, activities, climax, and denouement (Clandinin and Connelly 2000). Despite these analytic differences depending on the type of strategy used, qualitative researchers often use a general procedure and convey in the steps in data analysis. Figure 6.4 illustrates these steps:

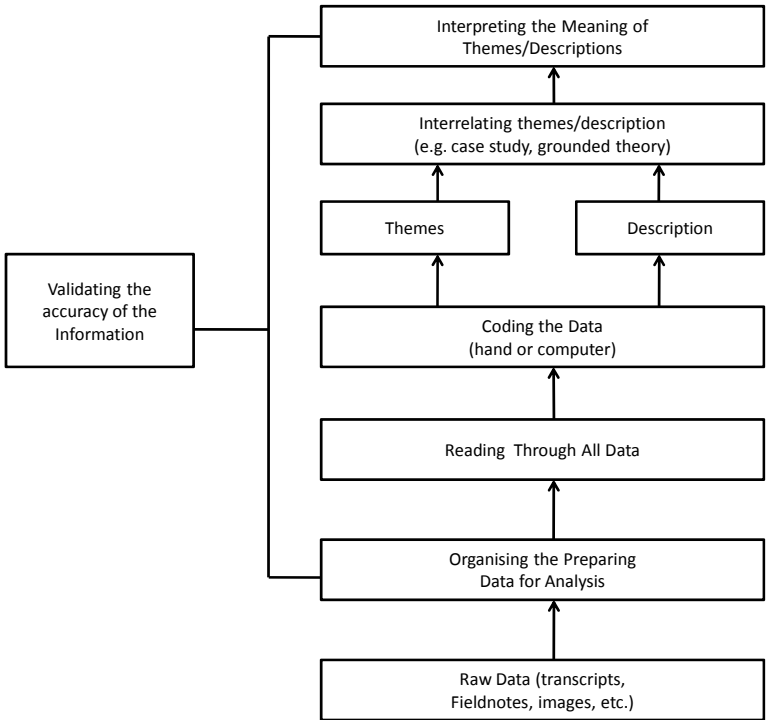


Figure 6.4: Qualitative Data Analysis Procedure (Creswell 2003)

Quantitative data analysis

The discussion on quantitative data analysis necessarily calls for some consideration of statistics. Quantitative analysis may be used at a number of levels: descriptive statistics (variable frequencies, averages, ranges); inferential statistics (assessing the significance of your data and results); simple inter-relationships (cross-tabulation or correlation between two variables); multivariate analysis (studying the linkages between more than two variables). One key point here is when carrying out quantitative analyses; it is often the question of causality (Creswell et al. 2003). One

of the purposes of analysis is to seek explanation and understanding between two or more variable, in that multivariate analysis is of importance and of interest of this study. Multivariate analysis has its roots in univariate (one variable) and bivariate (two variables) statistics. Multivariate methods of analysis are used to explore the inter-relationships among two or more variables simultaneously. Hair et al. (1998) define multivariate analysis as all statistical methods that simultaneously analyse multiple measurements on each individual or objet under investigation.

Multivariate analysis helps to expand the researcher's explanatory ability and statistical efficiency. Many multivariate techniques are available to analyse quantitative data with different objectives. For example, multiple regressions can be employed to predict the changes in the dependent variable in response to changes in the independent variables. Factor analysis is a statistical approach that can be used to analyse interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions (factors). Multivariate analysis of variance (MANOVA) is a statistical technique that can be used to simultaneously explore the relationship between several categorical independent variables and two or more metric dependent variables). Discriminant analysis is an appropriate multivariate technique if the single dependent variable is dichotomous (e.g. male-female) or multi-chotomous (e.g. high-medium-low). In short, the role of each variable in the analysis and the level of measurement reflected by each variable interact to produce a complex classification scheme of statistical analytical techniques.

Interpretation

A critical element of the data analysis process is arriving at the researcher's own assessment of what the results mean, and how these relate to other relevant research and writing in the subject area – it is 'interpretation'. Interpretation has been viewed as the process by which the researcher put his/her own meaning on the data that have collected and analysed, and compares that meaning with those advanced by others (Blaxter et al 2006). Interpretation in qualitative research means that the researcher

draws meaning from the findings of data analysis. This meaning may result in lessons learnt, information to compare with the literature or personal experiences. The connection between antecedents and consequences is reported and explained by describing the events that connect them (Einhorn and Hogarth 1986). However, describing patterns of event does not, by itself, explain the underlying process that generated the patterns. That said, all we first obtain in empirical research is the surface structure, as captured in our observations (Pentland 1995).

Explanation requires some insight and careful attention to the connection of surface and deep structure. Abbott (1992) terms this process of grabbing insights from surface structure into deep structure 'generating mechanism'. This generating mechanism process draws 'interpretation' into the heart of data analysis in qualitative method research. Interpretation of the results in quantitative research, on the other hand, is more straightforward. It means that the researcher draws conclusions from the results for the research questions, hypotheses, and the larger meaning of the results (Creswell et al. 2009). Similar to qualitative research, while having recognised, and begun to develop the researcher's perspective on what his/her quantitative research indicates, it also becomes important to review these views in the light of those of others. In doing interpretation, for both qualitative and quantitative methods research, the researcher has to engage in a more general consideration of the relevance and significance of his/her work.

The Study – Pattern Match and SEM

In this exploratory mixed method research project, data analysis is an important and complex process. Data are first managed (or examined) before analysing. Before analysing qualitative data, this study employs the processes of coding, annotating, labelling and selection (Miles and Humberman 1994; Blaxter et al. 2001) for data reduction and data display. In these processes, the techniques of 'seeing plausibility' and 'clustering' suggested by Miles and Humberman (1994) are employed to help coding, annotating, and labelling. Seeing plausibility is an initial impression that needs further checking through other conclusion-drawing techniques, or through

verification efforts. Clustering is a process to understand a phenomenon better by grouping and then conceptualising objects that have similar patters or characteristics (Miles and Humberman 1994).

The researcher further adopts the concept of replication logic (Yin 2003) by using the techniques of 'counting' and 'comparisons/contrasts' (Guba and Lincoln 1981) and Miles and Humberman 1994) to assist the process of selection. The technique of counting accommodates the selection of themes (or patterns) when (a) themes (or patterns) happen a number of times and (b) they consistently happen in a specific way (Miles and Humberman 1994). The technique of comparisons/contrasts is a classic way to test a conclusion. The researcher draws a contrast or makes a comparison between two sets of themes or patterns in important aspects (Miles and Humberman 1994). It helps the researcher to combine similar themes and to make the selection decision. In terms of quantitative examination, missing data, outliners, normality, linearity, and multicollinearity are examined before quantitative data analysis. The results of the survey research involved the sequential equation modelling (SME) test. Before running sequential equation modelling, the goodness of model fit is measured and ensured to be acceptable by confirmatory factor analysis (CFA).

Data analysis in mixed methods research relates to the type of research strategy chosen for the procedures. Analysis occurs both within the qualitative (e.g. description and thematic text or image analysis) and the quantitative (e.g. descriptive and inferential numeric analysis) approach (Tashakkori and Teddlie 1998). In doing exploratory multi-case studies, this study employs the 'pattern match' approach suggested by Eisenhardt (1989) and Yin (2003). It involves two steps: (1) analysing within-case data according to the methods described in Glaser and Strauss (1967) and Miles and Huberman (1994); and (2) searching cross-case patterns to shape propositions in exploring how firms learn about NPD in their business networks (Eisenhardt 1989; Yin 2003). In testing the propositions suggested by the multiple-case study, the researcher is facing with a set of interrelated questions. In dealing with the set of interrelated questions, structural equation modelling (SEM) provides

solutions and is employed in analysing quantitative data in this study (Hair et al. 1998). SEM techniques are distinguished by two characteristics: (1) estimation of multiple and interrelated dependence relationships; and (2) the ability to represent 'unobserved concepts' in these relationships and account for measurement error in the estimation process (Hair et al. 1998). Finally, interpretation is at the heart of the final process of data analysis. The findings and results from both qualitative and quantitative data analysis are integrated, compared, and contrasted back and forth with the existing literature until sensible interpretation is reached (Pentland 1995; Abbott 1992). Details will be further reported in chapter 7 (case study), chapter 8 (survey) and chapter 9 (interpretation and discussion).

6.5 METHDOLOGICAL SOUNDNESS

An important factor in any research design is establishing methodological soundness in which reliability, validity, and generalisability are of importance and are assessed differently between qualitative and quantitative methods research.

Reliability

The concept of reliability has to do with how well the researcher has carried out the research project. Has the researcher carried it out in such a way that, if another researcher were to look into the same questions in the same setting, they would come up with essentially the same results. If so, then the work might be judged reliable. Researchers of qualitative method research and researchers of quantitative method research obtain reliability in different way. Qualitative reliability refers to that a researcher's approach is consistent across different researchers and different projects (Gibbs 2007). In quantitative method research, reliability refers to whether scores to items on an instrument are internally consistent (i.e. are the items responses consistent across constructs?), stable over time, and whether there was consistency in test administration and scoring (Hair et al 1998). That is, quantitative reliability examines the extent to which a variable or set of variables is consistent in what it is intended to measure.

Validity

Validity concerns whether the methods, approaches and techniques actually related to, or measure, the issues the researcher has been exploring. Validity does not carry the same connotations in qualitative research as it does in quantitative research. Validity in qualitative method research means that the researcher checks for the accuracy of the findings by employing certain procedures (Creswell et al. 2009), while validity in quantitative method research concerns the extent to which a measure or set of measures correctly represents the concept of study, that is the degree to which it is free from any systematic or non-random error (Hair et al. 1998). Validity strategies in qualitative method research are procedure (e.g. member checking, triangulating data sources) that qualitative researchers use to demonstrate the accuracy of their findings and convince readers of this accuracy. Validity in quantitative research on the other hand, refers to whether one can draw meaningful and useful inferences from scores on particular instruments. Validity is concerned with how well the concept is defined by the measure(s), whereas reliability relates to the consistency of the measure(s) (Hair et al. 1998). Validity does not guarantee reliability, and vice versa.

Generalisability

Generalisability relates to whether the findings are likely to have broader applicability beyond the focus of the study. For quantitative researchers, generalisability concerns the question of 'To what extent does the study confirm or contradict existing findings in the same field?' (Easterby-Smith 2002). Qualitative generalisation is a term that is used in a limited way in qualitative research, since the intent of this form of research is not to generalise finding to individuals, sites, or places outside of those under study (Gibbs 2007). In fact, the value of qualitative research lies in the particular description and themes developed in context of a specific site. However, there are a few discussions in the qualitative literature about generalisability, especially as applied to case study research in which the researcher

studies several cases (i.e. multiple-case study). Yin (2003), for example, argues that qualitative case study results, relying on the replication logic, can be generalised to some broader theory. The generalisation occurs when qualitative researchers study additional cases and generalise findings to the new cases. In short, survey research relies on statistical generalisation, whereas case studies rely on analytical generalisation.

The Study – Mixed Methods Research

In addressing generalisability, this mixed methods research project uses the sequential exploratory strategy (i.e. qualitative method research followed by quantitative method research (Creswell 2003)), aiming to enhance the generalisability by testing qualitative findings to different samples. In the first phase of research, tactics to ensure case study methodological soundness suggested by Yin (2003) are employed. It deals with reliability, construct validity (to establish correct operational measure for the topics being studied); internal validity (concerns 'Is the inference correct?' 'Have all the rival explanations and possibilities been considered?'); and external validity (concerns analytical generalisability). Research design, data collection and data analysis are important phases to build up methodological soundness in case studies. Details will be discussed in chapter 7. In the second phase of research, to ensure the methodological soundness in the survey research, reliability, unidimensionality, convergent validity and discrimant validity are examined before running Structure Equation Modelling in this study. This examination involves assessing measures by Confirmatory Factor Analysis (CFA) in three steps: (1) to assess the goodness of fit indices; (2) to examine the unidimensionality, reliability, convergent validity and discrimant validity; and (3) to measure composite reliability (CR: method of combining several variables that measure the same concept into a single variable in an attempt to increase the reliability of the measurement) and Average Variance Extracted (AVE: average amount of 'shared' or common variance among the indicators or manifest variable for a construct). Details will be discussed in chapter 8.

6.6 CONCLUSION

Philosophical stance builds up the substantive basis for knowledge claims in doing research. Doing research in social science, it can be conceptualised in term of four sets of philosophical assumptions related to ontology, epistemology, human nature, and methodology. These philosophical assumptions can be viewed as general orientations about the world and the nature of research that the researcher holds. Four different views are identified and discussed: post-positivism, constructivism, advocacy / participatory, and pragmatism. The researcher holds a 'pragmatist' view by using the sequential mix methods approach to propose the theory and to examine the proposed theory to reach the research aim and objectives of the present study.

In collecting data in social sciences, four approaches (action research, case studies, experiments, and surveys) and four techniques (documents, interviews, observations and questionnaire) are discussed. In this study, exploratory multiple-case study is used to investigate empirical phenomena and propose propositions. Survey research is then employed to examine the proposed propositions. Purposive and snowball sampling strategies are used to collect qualitative data; and random sampling strategy is adopted to collect quantitative data. As a result, qualitative data are collected from three cross-industry case studies, and quantitative data are collected from 211 usable samples.

The collected data need to be processed before analysed. For data reduction and data display, qualitative data are managed by the processes of coding, annotating, labelling, and selection. The techniques of 'seeing plausibility', 'clustering', 'counting', and 'comparison and contrasting' suggested by Miles and Huberman 1994 are employed in managing qualitative data in this study. The concept of 'replication logic' is employed in searching patterns. The software NVivo is used to help qualitative data management. Quantitative data are examined by the evaluation of missing data, the identification of outliners, and the testing of assumptions

underlying multivariate techniques suggested by Hair et al. 1998. The software SPSS and AMOS are used in dealing with quantitative data in this study.

For data analysis, this study employs the process of 'pattern match' suggested by Eisenhardt (1989) and Yin (2003) by the processes of analysing within-case data and searching cross-case patterns. Structural equation modelling (SEM) is employed mainly in analysing quantitative data for evaluating multiple interrelated dependence relationships. The overall findings and results from qualitative and quantitative methods research are integrated and compared with the literature to generate deeper meaning. Details will be further reported in chapter 7 (case study), chapter 8 (survey) and chapter 9 (discussion). Finally, the methodological soundness in terms of reliability, validity, and generalisability is addressed. Figure 6.5 summarised this study's research methodology:

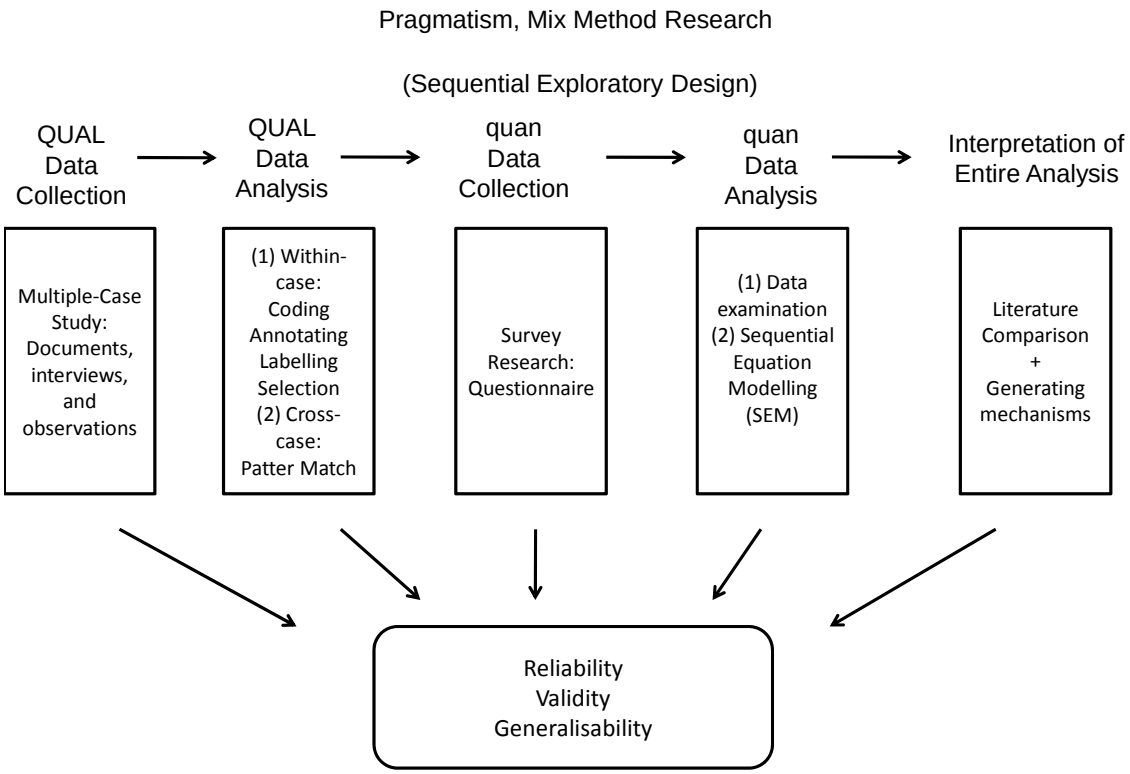


Figure 6.5: Mixed-Methods Research, Sequential Exploratory Design (Source: Author)

CHAPTER 7

PRESENTATION
OF
CASE STUDY RESULTS

CHAPTER SEVEN

7.0 Introduction

7.1 Qualitative Case Study

The Study

Methodological Soundness

7.2 Data Collection

Approach

Procedure and Selected Cases

7.3 Data Analysis

Analysing Within-Case Data

Searching Cross-Case Patterns to Shape Propositions

7.4 Results

Within-Case Data Analysis

Empirical Evidence

Cross-Case Patterns and Propositions

7.5 Conclusion

7.0 INTRODUCTION

This chapter aims to report and discuss the results of the multiple-case study conducted in this study. In exploring how firms learn about new product development in their business networks, a multiple-case study is employed to investigate empirical phenomena, providing evidence to the presented propositions. Section 7.1 summarises the case study design and implementation and discusses how the methodological soundness is reached. Section 7.2 details the data collection approach, procedure and the selected cases and samples in this study. Section 7.3 discusses the approach and methods used in analysing data. In this study, a procedure of analysing within-case data, searching cross-case patterns, and shaping propositions suggested by Eisenhardt (1989) is employed for data analysis. Section 7.4 reports the case study results. Results from within-case data analysis and cross-case patterns searching are discussed. As a result, six propositions are presented. Section 7.5 concludes this chapter.

7.1 QUALITATIVE CASE STUDY

This section discusses the case study employed in exploring how firms learn about product development in their business networks. It outlines its design, the processes of data collection and data analysis and discusses how the methodological soundness is established in the study.

The Study

Being an exploratory study into an under-researched topic area, this study is interested in proposition generation from case study evidence. The study employed qualitative case study and theory building techniques to explore how firms learn about product development in their business networks. Case study designs can be categories as single or multiple case designs as well as exploratory, descriptive, or explanatory case studies (Yin 2003). A multiple, exploratory case study design was used to explore the research topic. The decision to use exploratory case study was

based on that exploratory case study is useful for exploring relationships when the study variables are unknown and is powerful for theory generation (Yin 2003; Creswell 2009). The decision to adopt a multiple approach to the case design was based on both the diversity that is achieved from investigating multiple cases and the effects of analytical generalisation (or external validity).

This case study aims to uncover empirical practices on how the network learning takes place in successful NPD projects. A successful product development project was defined as one that has been brought from idea to commercial success. Case study protocol and semi-structured interview protocol (Appendix) were prepared before the field work started. The case study protocol specified an overview, field procedures, case study questions, and a guide for report. The interview protocol details the objectives, questions, procedure of the interview. Protocols not only helped to increase the reliability of the study, but also guided the researcher in carrying out the data collection consistently from three single-case studies.

In the study, semi-structured interviews together with observation, documents, and archived records were employed in exploring the practices. The interview followed the six distinct stages in product development process suggested by Booz, Allen and Hamilton (1982), namely, idea exploration/generation, idea screening, business analysis, development, testing, and commercialisation. Before the field work, a couple of pilot runs were conducted and found that the interview took too much time to discuss all six stages. The researcher also found that either the informant discussed very detailed for the first few stages and lost the momentum for the last few ones, or they just skipped some stages. Considering the feedback and practical reasons, the researcher grouped the six stages into three parts: (1) Idea management (Baker and Hart 1999) included the stages of idea exploration, idea screening, and business analysis; (2) Product development covered the stages of development and testing; (3) Commercialisation focused on commercialisation.

Data were collected by a ‘snow ball’ approach involving a ‘hub and spoke’ structure in three phases. The mechanism is detailed in the section of data collection. Case

study samples were purposefully selected for theoretical, not statistical reasons (Glaser and Strauss 1967). That is, samples were selected for their inter-firm learning experience in the selected successful product development projects. Triangulation was made by using multiple data collection sources: interviews, observations, documents, achieved record, company collaterals.

Data analysis was a big challenge in this study. In doing data analysis this study used the process suggested by Eisenhardt (1989): analysing within-case data, searching cross-case patterns, and finally shaping propositions. In building theory, the researcher generalised findings to 'theory' (or propositions) by employing various tactics suggested in the literature, such as pattern match, replication logic, constant comparison, clustering, and counting (Glaser and Strauss 1967; Eisenhardt 1989; Strauss and Corbin 1990; Yin 2003). Data analysis was often overlapping with data collection in this study. Overlapping data analysis with data collection allows the researcher to probe particular themes which emerged. For example, the insights of 'pollination' learnt from the data analysis in the second phase led the researcher to conduct the third phase of data collection for further understanding on this particular theme. Finally, propositions were shaped by iterating comparison process among data, emergent themes and the extant literature.

Two issues are important in data collection and data analysis: when to stop adding cases, and when to stop iterating between theory and data. This study employed the principle of 'saturation' suggested by Eisenhardt (1989). That is, the researcher stopped adding cases when incremental learning was minimal; and stopped the iteration process when the incremental improvement to the theory was minimal. Exploratory case studies have been commonly cited as part of a theory generating process (Glaser and Strauss 1967; Strauss and Corbin 1990). The multiple-case study provided a powerful means to create theory, with the contrast and diversity contributing to the richness of the resulting propositions.

Methodological Soundness

An important factor in any research design is establishing methodological soundness. Strong measures can be taken to build rigour into case study research at the research design, data collection and data analysis stages (Parkhe 1993). Four common tests are summarised, construct validity, internal validity, external validity and reliability, as the criteria for judging the quality of research design (Kidder and Judd 1986). In addressing validity and reliability, this study employed several case study tactics suggested by Yin (2003) for dealing with these issues.

Construct Validity

For construct validity, Yin (2003) suggests to establish correct operational measure for the topics being studied. Three tactics are available to increase construct validity when doing case studies. The first is the use of multiple sources of evidence, in a manner encouraging convergent lines of inquiry, and this tactic is relevant during data collection. A second tactic is to establish a chain of evidence, also relevant during data collection. The third tactic is to have the draft case study report reviewed by key informants.

In this study, several tactics were adopted to ensure construct validity. Data were collected through multiple sources. Four major data collection instruments were used in this study: documentation, archival records, direct observation and in-depth interviews. The case study investigated inter-firm learning in product development networks, a chain of evidence was establish via data collection from the hub organisation to its spoke organisations, from one hub to another hub, and from one spoke to another spoke. Finally, all the draft case study transcripts and reports were reviewed by key informants. More details will be discussed in the section of data collection.

Internal Validity

A case study involves an inference every time an event cannot be directly observed. A researcher will ‘infer’ that a particular event resulted from some earlier

occurrence, based on interview and documentary evidence collected as part of the case study. Internal validity concerns 'Is the inference correct?' 'Have all the rival explanations and possibilities been considered?' The analytic tactic of pattern matching is one way of addressing internal validity (Yin 2003). Three other analytic tactics: explanation building, addressing rival explanations, and using logic models are also suggested. To ensure internal validity, this study employed pattern match and explanation building suggested by Yin (2003) to process research data. The study further tied the emergent theory to existing literature to enhance the internal validity and generalisation (or external validity) as suggested by Eisenhardt (1989). Data analysis will be detailed in the following section.

External Validity

The external validity problem has been a major barrier in doing case studies. Critics typically state that single cases offer a poor basis for generalising. Such critics are implicitly contrasting the situation to survey research, in which a sample readily generalises to a larger universe. The researcher agrees Yin's (2003) argument that 'this analogy to samples and universes is incorrect when dealing with case studies' (p37). Survey research relies on statistical generalisation, whereas case studies rely on analytical generalisation. The researcher is striving to generalise a particular set of results to some broader theory. For the external validity, this study applied the use of multiple-case design and the replication logic using analytical generalisation as suggested by Yin (2003).

Reliability

The reliability of a research ensures that if a later researcher followed the same procedures as described an earlier researcher and conducted the same case study all over again, the later researcher should arrive at the same findings and conclusions. The goal of reliability is to minimise the errors and biases in a study. The general ways of approaching the reliability problem is to make case study protocol and develop case study database (Yin 2003). For reliability, this study employed case study protocol, semi-structured interview protocol and developed three sets of case study database from three studied cases. Details will be reported in the section of

data collection. Table 7.1 illustrates the tactic for methodological soundness for this case study:

Tests	Case Study Tactic	Phase of Research in which Tactic Occurs
Construct Validity	* Use of multiple sources of evidence	data collection
	* Establish chain of evidence	data collection
	* Have key informants review interview transcripts and reports	data collection
Internal Validity	* Do pattern matching	data analysis
	* Do explanation-building	data analysis
	* Enfold literature	data analysis
External Validity	*Use of multiple case design	case study design
	* Use replication logic using analytical generalisation	case study design
	* Enfold literature	data analysis
Reliability	* Use case study protocol	data collection
	* Use semi-structured interview protocol	data collection
	* Develop case study database	data collection

Table 7.1: Case Study Tactics for Methodological Soundness (Source: Yin 2003)

7.2 DATA COLLECTION

In studying business networks, it was well acknowledged that finding research samples is a big challenge (Håkansson and Johnson 2001). First, it is not easy to identify a complete web-structured business network with complex interconnected business relationships embedded in a set of connected relationships. Second, for data collection activities, a high rejection rate from informants is expected. In this study, 'snow-ball' approach by 'hub and spoke' structure was employed in three major phases of data collection. Furthermore, selection of cases is an important aspect of building theory from case studies. Theoretical (not random) samples (i.e. cases were chosen for theoretical, not statistical, reasons) were chosen (Glaser and Strauss 1967). This study purposefully selected samples with successful product development projects to build the theory from the successful practices and selected cases with good diversity to make sense of the replication logic. This section reports the cases selection and data collection details.

Approach

In order to tackle the challenge of collecting data in business networks, the researcher adopted a *'snow-ball'* approach. The data collection work started from promising samples (or informants), via a referral procedure, it then identified embedded quality informant(s) in their business networks. With this snow-balling effect, the sample size expanded successfully with embedded networked relationships in this multiple-case study research, which in turn provided good quality data. This snow-balling technique not only facilitated an effective method to identify qualified informants, but also it provided a very tight network-structured sample arrangement in studying the research topic in business networks.

In the study, 'hub' companies, where new product development is initiated, were selected as the starting points for data collection. The study was then extended to 'spoke' companies which appear as networked on either direct tie (e.g. its customer) or in-direct tie (e.g. its customer's customer) with a hub company. The snow-ball approach was in effect by this 'hub and spoke' structure (please see Appendix). The key informants were selected because they had knowledge of and information on the research topic in this case study. Data were collected by using multiple sources of evidence, mainly in-depth interview, documentation, archival records and direct observation. The use of multiple sources of evidence provided a more complete picture of each case under investigation and enabled the corroboration of any fact or finding for which there were reservations about (Yin 2003; Miles and Huberman 1994). Data collection ceased when new findings were minimum and repeated (Eisenhardt 1989).

To ensure reliability, a case study protocol and a semi-structured interview protocol (both in Appendix) were used to help address reliability issues and accommodate a degree of systemisation in the procedures and questions over the multiple cases. As mentioned earlier, the case study protocol provided guidance to conduct the field work. The interview protocol detailed both the definition of related topics and the outlines of a communication pattern. The interview protocol was also used as a

reminder to ask specific questions in the research areas. Interview participants were first asked to describe their successful new product development projects. Later in the interview the interviewees were asked their experience of working with network partners in the specified projects and asked to refer the mentioned network partners for further study. Company documents, collaterals and archival records were at the same time collected. The interviewees were thanked for participating and told he/she would receive a copy of the typed transcript of the interview. This was sent within a few days with a short cover letter shown in Appendix. In total, two individual returned the transcript with several minor corrections to the typed copy. Most participants provided an informal verbal response that they had reviewed the materials and it was fine. A few said there were minor but not important differences. In general the response indicated that participants did review their comments and found the transcript accurate.

Procedure and Selected Cases

As mentioned, case selection is critical to building theory from case studies. In this study, cases were carefully selected and data were collected in three major phases. Each phase achieved its own objectives. The respective case study database for three cases was built up from data collected in the three phases. The three phases of data collection and the participating companies are reported as below.

Phase One - Three Hubs

The objectives of phase one were to observe the empirical practices of inter-firm learning in product development networks and to carefully select three quality hub companies. Selection of cases is an important aspect of building theory from case studies (Yin 2003; Eisenhardt 1989). To accommodate the researcher with careful case selection, the first phase of the study involved intensive observation. The first phased research commenced with field observations in various product development and business network forums where inter-firm learning was facilitated and cultivated. The forums/seminars were selected by the following criteria: (1) it involved product development projects; (2) it provided business network opportunities; (3) the

participants were from different industries that offer the diversity of samples. As a result, four business forums in the UK were selected as a starting point for data collection for this study. Direct observations were used and notes were taken in related to the research topic. Details of the selected forums can be found in Appendix.

Six companies were careful selected for individual in-depth interview as potential hub-companies for this multiple-case study. An invitation letter with discussion agenda (see appendix) was sent to the selected companies prior to the interview, followed with a confirmation phone call. Each interview generally lasted for approximately an hour, but ranged from 40 minutes to two hours. The interviews remained open ended and assumed a conversational manner, while ensuring the discussion addressed the set of questions outlined in the protocol. Questions were kept deliberated broad to allow respondents as much freedom in their answers as possible. To ensure that all ideas and insights of the interviewees were noted accurately, a tape recorder was used in addition to note taking during the interview process. Data were transcribed from the cassette tapes with the transcripts sent back to participants to check for accuracy and clarify any confusion or inconsistencies.

Another important objective in the first phase is to decide the hub companies for the further study. Major selection criteria were: (1) companies with successful new product development project in the past three years; (2) the inter-firm learning was taken place in the company's product development networks; and (3) the willingness to provide the name list of their networked partners in the studied product development project. Finally, out of the six interviewed companies, three hub-companies were carefully selected for their outstanding performance in new product development by working with business network partners. To ensure validity, three selected hub-companies were from three different industries – e-business, tourism, and oil sectors. The three companies and their studied product development projects were summarised as below. Subject to the confidentiality agreement between the companies and the researcher, company identities are concealed.

(Hub C2E – e-Business)

The Company

Hub C2E was established in September 1996 as an independent supplier of internet products and services for business customers. C2E specialises in e-Business, ecommerce solutions, and search engine technology and search engine optimisation. For over ten years, C2E has led the way in combining creative design with best practice in usability and excellence in technical engineering. With major customers from around the UK, continental Europe and North America, C2E's websites lead the way in promoting online business, increasing sales volumes and contributing to business transformation. The Company has won a number of awards such as SPUR* and Scottish Software Awards.

The Successful NPD Project

C2E has developed a patented method called 'target market user profiling' (company's internal product name). The company has developed systems that use artificial intelligence methods to automatically identify and analyse what people type into search engines and rate these in terms of how competitive these search queries are. Resulting viability scores allow C2E's clients to identify special keywords and phrases that best connect a website with their target customers. The product provides a tool for its clients that marketing is transformed into a precise and analytical method that can be measured, planned for and improved on.

*(*SPUR award is in special recognition of highly innovative R&D projects that result in a pre-production prototype of a new product or process and that involve a significant technological advance for the industry or sector in the UK.)*

(Hub C4T – Tourism Industry)

The Company

C4T is a privately owned enterprise, founded in June 2003 by two partners. C4T networks with many well-known and desirable hotels to create a range of very sought-after gift voucher experiences. The company is the first online gift voucher service provider of its kind in the UK. The company has secured many high profile

clients (mainly 5 start hotels) since launching the business. C4T has won two awards in less than a year. The first innovation award that the company has won is the Tourism Innovation Development Award. The second award is the Innovation and Creativity Award at the Edinburgh Evening News Business Awards.

The Successful NPD Project

C4T provides the service 'gift on an idea' - an online gift voucher service which covers: staff incentives, corporate thank you gifts, rewards, retirement gift and Christmas gifts. The company enables businesses (mainly in hotels) to use/sell gift vouchers – for gifts that can range from spa treatments and golf lessons to weekend breaks and champagne dinners, which results C4T's clients generating incremental revenue and providing an extra service to their customers.

(Hub C5O – Oil Industry)

The Company

C5O is a mechanical engineering company founded in 2001 and based in Aberdeen, Scotland. The company specialises in provision of engineering services and production equipment for both operators and service Companies in the oil and gas industry. The company believes that a culture of openness maximises the return on investment. They welcome customer involvement and see suppliers as partners. The Company is the Oracle Business Innovation of the Year award winner. The award is part of the National Business Award for Scotland.

The Successful NPD Project

As global oilfields are maturing and all the "easy" oil has been produced, different techniques are used to extract the oil from the ground. Some of the challenges operators are dealing with were steam flood/steam drive where temperatures of up to 600 degree (F) are required to produce heavy oil. The common problem with the challenges listed above is the sealing technology. C5O successful produced a new product (a metal-to-metal seal) to cope with the high levels of H2S/CO2 and finding down-hole equipment suitable. A metal-to-metal seal allows the operators to break through several barriers and drill and produce from wells that are currently beyond

the limits. The product solves many of the problems and allows C5O's clients (mainly in the oil and energy industry) to confidently develop their fields.

Phase Two - Direct Tie Spokes

The second phase of the case study focused on the data collection from the spoke companies having direct tie (e.g. customer, supplier) with the hub companies for the studied product development project. By the snow-ball approach, these spoke companies were referred by the hub companies. Four major data collection instruments were used: documentation, archival records, direct observation and in-depth interview. An invitation letter with agenda (see appendix) was sent to the recommended first layer spoke companies prior to the interview, followed with a confirmation phone call. Interviews lasted approximately 30 minutes to 60 minutes, focusing on the topic of how inter-firm learning takes place in the studied product development project. Documentary information related to the studied product development project was collected, which included: letter, memoranda, agendas, announcements, minutes of meetings news clippings and other written reports. Archival records were collected, such as service records, organisational records, and company collateral. Notes were taken from the direct observation. Interview data were transcribed and sent back for confirmation or clarification. Data from the second phase revealed that inter-firm learning on the studied project was not ceased at the direct tie companies, but extended to companies with indirect relationships with the hub, for example customers' customer. At the end of the interview, spoke companies were asked to provide contact details of their network companies that also involved in the studied project.

In total, in e-business sector, data were collected from 8 direct tie spoke companies; in tourism industry, 8 direct tie spokes; and in oil industry, 9 direct tie spokes. Table 7.2 summarises the demographics of the hub and the spoke companies (direct-tie) and the informant's background in this phase.

COMPANY	INDUSTRY	Relationship w/ Hub Firm	NO. OF STAFF	INFORMANTS' POSITION	GENDER	LENGTH OF INTERVIEW
C2E	e-Business	**Hub**	25	Founder	Male	90 min'
c1	e-Business	customer	200	Product Development Team Leader	Male	55 min'
c2	e-Business	customer	35	Managing Director	Male	45 min'
s1	e-Business	supplier	550	Product Manager	Male	30 min'
s2	e-Business	supplier	69	Sales Manager	Female	30 min'
3p1	e-Business	3rd party	35	General Manager	Male	45 min'
com1	e-Business	competitor	200	Product Development Team Leader	Male	55 min'
3p2	e-Business	3rd party	30	Service Manager	Male	30 min'
jv1	e-Business	joint venture	80	Engineer	Female	60 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'
C5O	Oil	**Hub**	50	Managing Director - MKG, PD	All Male	70 min'
c1	Oil	customer	97,000	Operations Engineer	Male	45 min'
c2	Oil	customer	108,000	Well Engineer	Male	30 min'
c3	Oil	customer	30,000	Technology co-ordinator	Male	30 min'

c4	Oil	customer	80,000	Well Ops. Engineer	Male	45 min'
jv1	Oil	joint venture	80	Product Manager	Male	60 min'
3p1	Oil	3rd party	300	Advisor	Male	50 min'
3p2	Oil	3rd party	100	Technology Co-ordinator	Male	30 min'
s1	Oil	supplier	30	Production Director	Female	25 min'
s2	Oil	supplier	100	Purchasing Manager	Male	45 min'

Table 7.2: Hub and Direct-tie Spoke Company's Profile (Source: Author)

Phase Three - Indirect Tie Spokes

Data collection procedure in the third phase was similar as the procedure in the second phases except it focused on the data collected from the spoke companies which had indirect tie (e.g. customer's customer, supplier's supplier) with the hub company. The second layer spoke companies (with indirect tie with the hub) were referred by the first layer spoke companies (with direct tie with the hub). An invitation letter was sent out before the interview followed by a confirmation phone call. Data were mainly collected by the in-depth interview together with documentation, archival records and direct observation. Interviews lasted about 30 minutes to 45 minutes. Interview topic focused on how working/learning takes place between the first layer and second layer spoke companies in regard to the studied product development project. In total, for e-business sector, data were collected from 4 indirect spoke companies; for tourism industry, 4; and for oil industry, 3. Table 7.3 summarises the demographics of those indirect spoke companies and their informants.

COMPANY	INDUSTRY	Relationship w/ Hub Firm	NO. OF STAFF	INFORMANTS ' POSITION	GENDER	LENGTH OF INTERVIEW
C2E	e-Business	**Hub**				
c1-1c	e-Business	customer's customer	300	Marketing Specialist	Male	45 min'
c2-1s	e-Business	customer's supplier	25	General Manager	Male	30 min'

s2-1s	e-Business	supplier's supplier	150	Purchasing Specialist	Female	25 min'
s2-2c	e-Business	supplier's customer	20	Marketing Director	Male	30 min'
C4T	Tourism	**Hub**				
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	25 min'
C5O	Oil	**Hub**				
s1-1c	Oil	supplier's customer	10,800	Engineer	Male	25 min'
s1-2s	Oil	supplier's supplier	75	Service Engineer	Female	30 min'
s2-1c	Oil	supplier's customer	25	Managing Director	Male	30 min'

Table 7.3: Indirect Tie Spokes Company Profile

Finally, in this multiple case study, data were collected from 3 hub companies with 36 spoke companies (25 direct tie spokes + 11 indirect tie spokes). In each case data were collected from one hub companies and 12 spoke companies. The data collection was ceased due to the new findings were minimum and repeated (Eisenhardt 1989). Table 7.4 summarises the samples' allocation by their roles as business network partners (spokes) to the hub organisations.

	e-B	Tourism	Oil	
Hub	C2E	C4T	C5O	3
Customer	2	3	4	9
Customer's customer	2	2		4
Distributor		1		1
Supplier	2	1	2	5
Supplier's supplier	1	1	1	3
Supplier's customer	1	1	2	4
Competitor	1			1
Joint venture	1	1	1	3
3rd party	2	2	2	6
Total	13	13	13	39

Table 7.4: Case Study Sample Allocation (Source: Author)

7.3 DATA ANALYSIS

In doing exploratory case studies, data analysis is a critical and complex process and is at the heart of building theory from case studies. Unlike hypothesis-testing research, inductive research lacks a generally accepted model for its data analysis process. Qualitative data analysis can be both the most difficult and the least codified part in the process (Eisenhardt 1989; Yin 2003). In the absence of a standard, the researcher employed the process of analysing within-case data, followed by searching cross-case patterns to shape propositions as suggested by Eisenhardt (1989). Within-case data are content processed by the methods suggested by Glaser and Strauss (1967) and Miles and Huberman (1994); and cross-case patterns are searched through cross case or multi-case analysis methods suggested by Eisenhardt (1989) and Yin (2003). Nvivo 7 (a computer-aided text analysis software package specifically designed to enable coding for qualitative data analysis) is used to help the researcher to code and categorise large amounts of narrative text collected from semi-structured interviews, and of extracts from documents and archival records (Pazeley and Richards 2003). Tables and lists were used to summarise and tabulate the evidence underlying the constructs (Miles and Humberman 1994). This section first discusses how data are processed, managed, and analysed in within-case data analysing stage, followed by the discussion of searching cross-case patterns and shaping propositions.

Analysing Within-Case Data

Before data analysis, within-case data were first processed. It involved detailed case study write-ups from 'raw data' in three cases. These write-ups were simply pure descriptions, and then were coded and put into the appropriate category. The processes of coding, annotating, labelling and selection (Miles and Humberman 1994) helped the researcher to cope early in the analysis process with the enormous volume of data. In the process of data reduction and data display, the researcher employed tactics suggested in the literature. During documentation of the analysis efforts, the researcher employed methods of the 'seeing plausibility' suggested by

Glaser and Strauss (1967) and Miles and Huberman (1994) to code the data. The seeing plausibility was an initial impression that needed further checking through other conclusion-drawing tactics, or through verification efforts. The researcher used the 'clustering' method (Miles and Humberman 1994) to put the coded descriptions into appropriate category for each case. Clustering helped the researcher to group and conceptualise coded descriptions that have similar characteristics or attributes. The researcher made comparisons/contrasts to find similarities and differences among categories. This step helped the researcher to check and verify the coded themes and to see for any added evidence of the recurring regularities (Guba and Lincoln 1981). Through the iterative process of coding, re-coding and categorisation, data display together with data reduction helped to 'transform' raw data into meaningful information in searching answers to the research questions (Miles and Huberman 1994). Three sets of database were developed and stored. Each case built an explanation 'box' organised by themes. Three case 'boxes' were built and stored for case e-business, case tourism, and case oil.

Searching Cross-Case Patterns to Shape Propositions

After analyzing within-case data, the researcher moved to search for cross-case similarities and patterns. It allows the researcher to understand the phenomena beyond each individual case and increases the generalisability of the observations (Eisenhardt 1989; Yin 2003). In searching for cross-case patterns, the pattern-match approach described by Eisenhardt (1989) and Yin (2003) was used. If the patterns coincide, the results help to strengthen the study's internal validity (Yin 2003). The pattern-match approach is more complex in multiple-case study than in single case study. Analysis tactics suggested in the literature were employed to help searching cross-case patterns.

The 'constant comparative method' described by Glaser and Strauss (1967) and Strauss and Corbin (1990) was used to identify within-/inter- case similarities and differences. The method relies on continuous comparison of data and the emergence of theoretical categories from evidence. To uncover and examine the key themes in

the data, data were processed, reduced and organised constantly until themes were appeared and cross-case patterns were emerged. The counting tactic employed in this study was 'counting'. Miles and Humberman (1994) suggest that when themes are identified, a generalisation often comes from something that: (1) happened a number of times and (2) consistently happens in a specific way. The 'number of times' and 'consistency' judgement are based on counting. Something is 'important' or 'significant' or 'recurrent' often comes from that estimate by making counts (Miles and Humberman 1994). 'Counting table' of the number of interviewees whose statements affirm/imply the coded corresponding concept is used to searching cross-case pattern. Counting table reports and compares the number of interviewees whose statements affirm/imply the coded corresponding concepts in three cases. A counting table for emergent theme reports the major themes suggested by the multiple-case study. Details are demonstrated in the attachment.

In searching cross-case patterns, the idea of 'replication logic' (Yin 2003; Eisenhardt 1989) was also used. In replication logic, cases which confirm emergent patterns enhanced confidence in the validity of the relationships. Cases which disconfirm the relationships often provided an opportunity to refine and extend the theory. For example, in this study the emergent theme 'the cross-transformation of knowledge' was first found in one case and was replicated in other cases. 'The cross-transformation of knowledge' was a theme proposed by this thesis and little literature could be found to fully explain the phenomenon. The replication logic gave the researcher confidence to shape the proposition.

In shaping propositions, methods suggested by Eisenhardt (1984) were used. From the within-case analysis plus various cross-case tactics, tentative themes and patterns were emerged. This was an iterative process during which relationships between variables began to emerge. The next step of this iterative process is to compare systematically the emerged relationships with the evidence from each case in order to assess how well or poorly it fit with case data. The researcher constantly made comparisons between emergent relationships and evidences – iterating toward propositions which closely fits the data were shaped. A close fit is important to

building good propositions because it takes advantage of the new insights possible from the data and yields empirically valid propositions (Eisenhardt 1984). When a proposition was supported, the case study data often provided a good understanding of the dynamics underlying the relationship, which in turn helped to establish the internal validity of the study.

A critical step of shaping propositions involved enfolding literature. An essential feature of theory building is comparison of the emergent proposition with the extant literature (Eisenhardt 1984). This involves asking what is this similar to, what does it contradict (and why) to the literature. In the study, similar findings with literature enhanced the proposition with stronger internal validity, wider generalisability and higher theoretical level of theory building from case study research. Findings conflicting literature, on the other hand, represented an opportunity in this study. The result deepened insight into both the emergent theory and the conflicting literature.

In sum, data and the emerged patters from one case were compared those from the other two cases. Emerged patterns were developed and matched by comparing within- and cross- case similarities and differences. Notes and data from field observation, documentation and archival records were used to verify data from interviews. Lists and tabulations were used for the comparison. In replication logic, replicated patterns were identified by the iterative exercise of this pattern searching process. In shaping propositions, the matched (or replicated) patterns were constantly compared with the extended literature. Figure 7.1 illustrates the entire data analysis procedure:

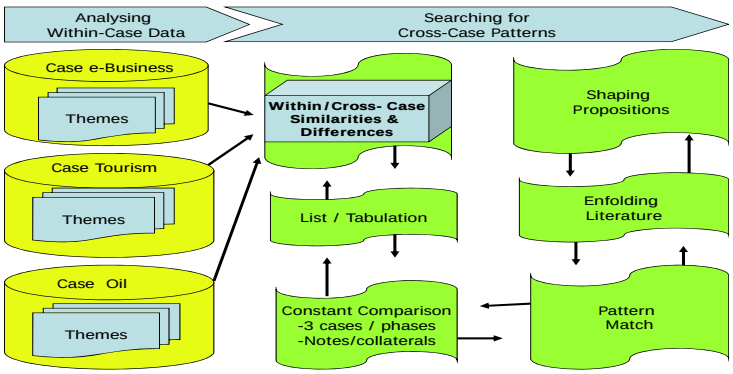


Figure 7.1: Data Analysis Procedure (Source:Eisenhardt 1989)

7.4 RESULTS

This section reports the results of the data analysis of the multiple-case study in exploring how firms learn about product development in their business networks. Results of within-case data analysis are first reported. As mentioned earlier, for practical reasons the researcher grouped the six stages into three parts for discussion: (1) Idea management (Baker and Hart 1999) included the stages of idea exploration, idea screening, and business analysis; (2) Product development covered the stages of development and testing; (3) Commercialisation focused on commercialisation. As a result, six major themes are emerged. Cross-case patterns are then analysed, followed by empirical evidence in three cases. How business network learning processed in NPD and how firms engage with alliances in the NPD network learning process are first discussed, followed by the question how the network learning mechanism impact on NPD uncertainty reduction and speed-to-market. As a result, five propositions are shaped and presented by an iterative comparison process among emergent relationships, empirical evidence, and the extant literature. Tables and charts are used to help the analysis and comparison in the data analysis process.

Within Case Analysis
And Emergent Themes

Iterative processes of data reduction and data display were conducted in three cases respectively. Companies were first asked how they learn from their network alliances at three stages (idea management, product development, and commercialisation), and then were asked how the business network learning mechanism impacts on the uncertainty reduction and speed-to-market in the NPD projects. The methods of seeing plausibility, clustering, among categories were used at this stage. In total, sixteen coded ‘nodes’ were found repeatedly appeared in three cases: articulation (A), collective learning (CL), learning by comparison (CPR), documentation (D), experience (E), early involvement (EI), formal/informal meeting (F&I), information sharing (IS), learning be challenged (LBC), learning by doing (LBD), late involvement (LI), pollination (P), regular dialogue (RD), refinement

(RFN), transformation (T), trial and error (T&E). A 'case-by-attribute' table and counting table (the number of interviewees whose statements affirm/imply the coded corresponding concept at the three stages of NPD process) summarised these sixteen coded nodes for the case of e-Business, of Tourism, and of oil. These tables can be found in the Appendix. The researcher then used the constant comparative method to check and verify the repeated coded nodes among three cases until major themes were emerged. As a result, six major themes were emergent. See Table 7.5 for a summary of the emergent themes.

Emergent theme	Description	Supported Coded Nodes	Supported Literature
The Transfer of Existing Knowledge	A n effect of access, assimilation, and dissemination of knowledge	IS (information / knowledge sharing)	Cyert and March (1963); Daft and Weick (1984); Cohen and Levinthal (1990); Inkpen (1996/2000);
The Cross-Transformation of Advanced Knowledge	A cross effect of student-teacher transformation through receive, develop, and share knowledge with network alliances	CL (collective learning); T (transformation)	Beamish and Berdrow (2003); Marsh and Stock (2006)
Dialogue	On-going communication	EI (early involvement); F&I (formal/informal meeting); LI (late involvement); RD (regular dialogue)	Issaacs (1993); Schein (1993); Beeby and Booth 2000; Hazen (1994); Nonaka and Toyama (2002)
Articulation	Turn tacit knowledge into explicit	A (articulation); CPR (learning by comparison); LBC (learning by being challenged); LBD (learning by doing);	Hedlund (1994); Grant (1996); Nonaka (1994); Holmqvist (1999); Nonaka and Toyama (2003); von Hippel and Katz (2002)
Pollination	Integrate knowledge, knowledge fuse	P (pollination); RFN (refinement)	Pyka (2002); Marsh and Stock (2003/2006)
Experience	Apply the experience from past learning	E (experience); D (documentation) T&E (trial and error)	Levitt and March (1988); Powell (1998); Levinthal and March (1993); Pyka (2002)

Table 7.5: Six Emergent Themes Content Analytic Table (Source: Author)

The study found that the activities of assessing, assimilating, and disseminating of the existing knowledge in collaborated NPD projects repeatedly appeared in three

case studies. This study terms the involvement of these activities as the ***'transfer'*** of existing knowledge. The knowledge transfer has been viewed as the centre of the firm's processes between a parent company and its alliances (Inkpen 1996; Marsh and Stock 2003; Carlile 2004). It comes from a mature root in the literature of learning – the process of accessing, assimilating, and disseminating information (Cyert and March 1963; Daft and Weick 1984; Cohen and Levinthal 1990; Moorman 1995; Inkpen 2000). The concept of 'transfer' has its basis in the information-processing approaches to boundaries in organisation theory (Lawrence and Lorsch 1967; Galbraith 1973).

Results of three case studies reveal an important phenomenon after the transfer of knowledge when learning taking place in NPD networks. This study terms these phenomena *the* ***'cross-transformation'*** of advanced knowledge and described as below:

A student company (say, Company A) receives knowledge from its teacher company (e.g. its customer, Company B). The received knowledge is absorbed by Company A and integrated with company A's existing knowledge, and developed into advanced knowledge. The developed advanced knowledge then becomes Company A's existing knowledge; and Company A (used to be the student company) transforms into a teacher company. A new student company (say Company C) comes in the NPD collaboration with Company A. Company A (then a student company) now is the teacher company to Company C (a student company). Company A's knowledge is received and developed (through absorption and integration) into a more advanced knowledge by Company C, and then becomes Company C's existing knowledge. Company C (used to be a student company) transforms into a teacher company.

This phenomenon is reiterated among NPD network partners. The study also indicated that a student company may learn from multiple teacher companies (e.g. customer, customer's customer, supplier, etc.) in one NPD project; and a teacher companies may share knowledge to multiple student companies as well. This study terms this phenomenon as the '*cross-transformation*' of advanced knowledge to

depict the effect student-teacher transformation across the NPD learning networks. In the literature, the concept of the cross-transformation is still an under-researched area.

In solving problems in complex systems like NPD, to tap the collective intelligence of knowledgeable people is found employed by product developers. This phenomenon echoes the theory of ***'dialogue'*** depicted in the literature (Issacs 1993; Schein 1995; Beeby and Booth 2000). Case study data indicate that tacit knowledge (i.e. knowledge that is hard to formalise and communicate or share with other firms) is often a challenge in the transferring process among NPD network partners. The study found that companies often talked to the experienced personnel from their NPD network partners, learnt by doing via trial and error, educated its NPD personnel with knowledge form NPD alliances, and frequent studied allied company's documents. Empirical evidence suggests that the involvement of these activities helped allied companies turn tacit knowledge into explicit and is critical to the transfer of knowledge. This phenomenon is broadly consistent with the theory of ***'articulation'*** claimed by scholars (e.g. Hedlund 1994; Nonaka and Toyama 2003). Case study data indicate that ***experience*** is critical to facilitate NPD network learning for that it provides a base for company to engage dialogue and cultivates a shared sense for company to engage articulation. Further, empirical evidence indicates that in the process to develop advanced knowledge, a student company receives knowledge from its teacher company and integrates the received knowledge with its existing knowledge. This study terms this phenomenon ***'pollination'***. It is the engagement of pollination that seeds the cross-transformation of advanced knowledge. The study borrows pollination's semantic implications that the effect of pollination causes a flower or plant (NPD network learning) to be able to produce seeds (advanced knowledge) by adding or bring pollen (receive and integrate different knowledge from teacher companies). Flowers are pollinated by bees; NPD network learning is pollinated by boundary spanners (Perrone et al. 2003). Further literature review in regard to these six themes can be found in Chapter 4. Table 7.6 illustrates the number of interviewees whose statements affirm/imply these six themes in three cases.

Table 7.6 Counting Table – Emergent Themes

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

Emergent Theme	Support Coded Node(s)	Case Oil	Case Tourism	Case e-Business	Supported Theme Total Counting
The Transfer of Knowledge	IS	17	23	21	61
The Cross-Transformation of Knowledge	CL	10	7	13	30
	T	4	11	6	21
Dialogue	EI	5	14	4	23
	F&I	13	3	7	23
	LI	0	5	0	5
	RD	12	7	7	26
Articulation	A	6	10	16	32
	CPR	4	8	6	18
	LBC	5	7	13	25
	LBD	9	12	4	25
Pollination	P	9	8	12	29
	RFN	4	12	4	20
Experience	E	9	8	4	21
	D	2	1	6	9
	T&E	14	8	3	14

Note:

A (articulation); CL (collective learning); CPR (comparison screening learning); D (document);E (experience); EI (early involvement); F&I (formal/informal meeting); LBC (learning by challenged); LBD (learning by doing); LI (late involvement); P (pollination); RD (regular dialogue); RFN (refinement); T (transformation); T&E (trail & error) (Source: Author)

Empirical Evidence

In reporting empirical evidence from within case data analysis, narrative approach by a story telling style is used for a coherent progression in the studied cases (Hermanns 1995, Schutze 1977, 1983). First the initial situation is outlined ('how everything started'), then the events of interest are selected ('how themes emergent'). Each case will be concluded by a case discussion and summary learnt from case evidences. Footnote (informants or sources; theme/code; extract) is used to specify the source,

the coded themes (D: dialogue; A: articulate; P: pollination; E: experience; TSF: transfer; CRT: cross-transformation; UR: uncertainty reduction; SP: speed-to-market) and extract readings (t: case tourism; e: case e-business; o: case oil; i: idea management; p: product development; c: commercialisation). All the names in the stories are pseudonyms.

(Case Tourism)

This is a true story that happened in the tourism industry…It was the year of 2005 in Scotland…

Idea Management

'Voucher' was a traditional marketing tool for promotional activities in hotels business. The fulfilment had been a big hassle to hotel managers for a long time.

Ann and Kate were very good friends since high school. Both of them were also working in hotel management for many years. It was an afternoon; they had their usual coffee chatting time at a café on Prince Street in Edinburgh. Kate, a marketing manager for a five start hotel, had a very bad day, she had spent whole morning to do nothing but only to handle some very tedious work for vouchers they had been doing for years. They had been using vouchers without knowing how to monitor the process? Without knowing how many voucher were sold, redeemed? What's the revenue? How many due to come in? It had been a headache for Kate since long. Kate was so frustrated that Ann started worrying about her…

One week after, Ann and Kate were having their afternoon coffee chatting time again. This time, Ann brought an idea, which was inspired by Kate's problem earlier, 'online voucher service'. The more they talked about the online voucher idea, the more they were excited. They decided to consult friends and colleagues about this idea. Eight months after, they quit their jobs and formed their own company - C4T. C4T's first and main product was 'online voucher service'. C4T's niche market was 5 starts chain hotels. The idea was managed for development

feasibility by consulting C4T's business partners, such as possible suppliers, distributors. Six months after, Ann and Kate decided to involve their prospecting customers early on in order to develop a product that market really needed.

Kate, Managing Director of C4T, approached their first customer (C4T-c1) in a beautiful summer day in Haymarket, Edinburgh. John, marketing manager of C4T-c1 recalled how it was happened… *(Interview Notes)*

D → TSF

"I was approached by Kate 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 said she had a new system that she would like to potentially introduce. And she asked if she could come to the C4T-c1 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 and Ann. They are from hotel industry. They know how to grab the real issues quick! "

E → TSF

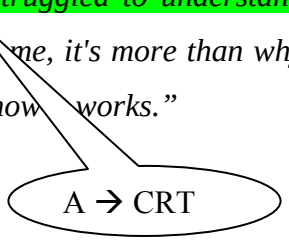
(C4T-c1; DE, TSF; Extract ti1)

Yes, the hotel work experience helped Kate and Ann to learn with their potential customer more and quick. Kate shared her experience.

P→ CRT

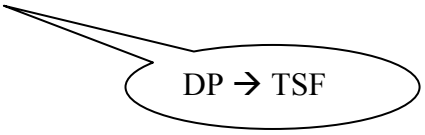
"*Yes. We learnt so much from our customer. Each of our customers is slightly different, obviously. And they would have their own internal procedures. But there are lots of similarities. We learnt this early on as now we are targeting larger clients who have multiple properties (chain hotels). For example, we are targeting the international companies. We did get them. As C4T-c1, they went alive. And they've got 40 hotels across Europe. And then, their needs may be different. They want different currency; they want to have different reporting functions. And yes, they would not choose the*

business with us if we have not learnt what their needs are, and update our system to accommodate what their needs are. In the beginning there were some issues that I did not understand, because of my lack of understanding on their finance, particularly. And I struggled.. I struggled to understand what they wanted and why they wanted. Because for me, it's more than why you want it! More importantly, I need to understand how works."
(C4T; AP,CRT; Extract ti2)



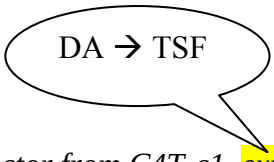
Kate paused a little while and added:

"In some cases, we managed some three-way discussions in which we involved customer and customers' customers to try to understand the key issues that they had, but only with the conjunction with the company C4T-c1. We found by this way, we learnt more."
(C4T; DP, TSF; Extract ti3)



Product Development

To learn how the new product might work for customers is important to C4T. In developing their new idea into real product, Kate from C4T found that learning from customers contributed enormously to make their dream come true, or even better than their 'dream product'. She reflected this learning process and gave an example…



"I was quite honest with the Financial Director from C4T-c1, explained that I did not understand their operation, and ask is he could help me to understand. He did. He was quite patient, and we went through very detailed process. Then, I turned to the accountant, specifically, for what they wanted in their 40 properties (chain hotels). They told me they wanted all fund to go to one account. And they didn't want to pay the hotels for the gift vouchers until the recipients of redeemed gift came back. For their centre account, what they looked for was liability with the fund. So they could press

the button and the system would tell him how many live vouchers are still yet to be redeemed, how many that haven't expired, how many that haven't been used, how many that that haven't been cancelled, and how many that haven't been refunded. And it took me a while to understand all those features they needed. So, that was a big learning experience for me. Because I had never been that situation before, I don't know that side of business. I've never worked that financial capacity of organisations."

(C4; DA, TSF; Extract td1)

A → TSF

Kate looked very excited and continued.

E → CRT

P → CRT

But now, when our customer wanted things specifically for their business, I understand better and always provide good solution for them. It was the learning from other hotels helped me. To be honest with you, the way I look at it is we built a product from what you called inter-firm learning. And I bet lots of customers want it. We don't think that this product is just for C4T-c1 one customer. But this product, what we have developed, will benefit us in a long run. Because we will be able to go to other client, like C4T-c2, and say 'look what we got!'. So, we will use what customers told us to sell to other customers.

(C4; PE, CRT; Extract td2)

P → CRT

In developing product, experience seems playing an import role in inter-firm learning. Larry (C4T customer) had also once recalled some issue in dealing with vouchers, which found identical with Kate's experience. This helped Kate to win the business …

A → TSF

"We knew that we were selling many vouchers per year. But we weren't sure how many. Different vouchers would require different system, different business, and different software. So, we weren't aware exactly how much we were selling, we weren't aware how many were redeemed; we weren't aware what the popular type of voucher was. We couldn't run reports; we couldn't

drop headlines until Kate came to me with C4T's product. She did make my life easier! (Laughing)"

(C4T-c2; AE, TSF; Extract td3)

E → TSF

With a lot of appreciations from working with Kate, Lisa from C4T-c1-1c (C4T's customer's customer) expressed:

D → TSF

A → TSF

…Through many meetings and discussions, she (Kate) chatted and met with our staff. And she followed that with many questions. Then, in their proposal, she (Kate) included the requirement for each department and how C4T could do for those needs…It's basically coming back and feeding that information through experience of each department"

(C4T-cl-1c; DAE, TSF; Extract td4)

E → TSF

How did C4T manage the knowledge learnt from customer and turn what they learnt into product? Ann from C4T reflected…

D → TSF

A → TSF

"*…therefore, there is an open communication channel between (C4T and C4T-c1). For example, we've got a year's worth development work, waiting to be done…So, what we would do is we get feedback from customers. And me and my partner, Kate, literally sit down for couple hours, and brain storm and think, imagine ourselves are customers, imagine ourselves as users, imagine ourselves as consumers. And what would be the ultimate scenario, what would be the ultimate experience. And then, we document that into a formal review's cases, and that involves our technology partner C4T-s1. We then had many meeting and worked intensively with C4T-s1 and started scoping the project…"*

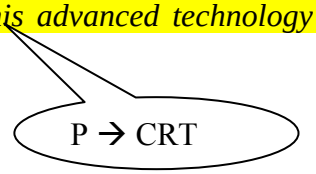
(C4T; DAE, TSF; Extract td5)

E → TSF

Comments from Larry from C4T-s1 (supplier) coincide what Ann was described.

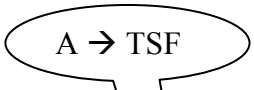
"…I think they (customer) *have the majority of credit* (for product development). *They went away with the feedback we gave them and collaborating some elements from their customer into it to get it work, and then ask us to produce the product. This is good for both companies. Because they want to create a solution that was the best for them. It helped us to get new ideas. And we also used this advanced technology to other companies…"*

(C4T-s1; P, CRT; Extract td6)



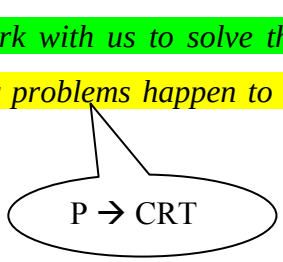
Commercialisation

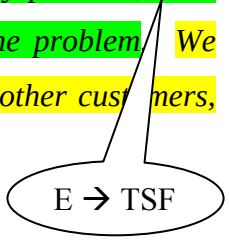
Inter-firm learning in business networks did not stop at the product development stage but it continued at the commercialisation stage. Linda from C4T-d1 (C4T's distributor) experienced it all…



"We learnt that no matter how much testing we do, things would still go wrong. (laughing). Before launching the product we had tested many times. and yes, some problems happened during the testing, and we fixed them. BUT when we launched it, there were still problems. For instance, their on-line voucher system at the payment stage, it uses the payment divider process. And I think the first day we went alive, unfortunately, the protect system had an internet security breach. And we took it down. So, when our customer was getting the payment stage, and it was not getting any further. That's something we couldn't really account for. In the first month or so, the fulfilment company of C4T also got it wrong a few times. Either forgot to deliver the voucher, or deliver to the wrong address. These are the things you can't control, so to speak. (Linda looked a bit of frustrated) But C4T were very good at going to the external party they chose, and making sure that was solved and won't happen again. When there is any problem, Kate and Ann always talk with us and work with us to solve the problem. We learnt a lot from them. When similar problems happen to other customers, we always manage them better.

(C4T-d1; APE, TSF/CRT; Extract tc1)





Kate from C4T echoed what Linda described.

> *…At commercialisation stage, the interaction with customers was quite a lot, regards to problems. So, talk to customers, to distributors to find out what the problem was. You know, one thing that came up on the 2nd day was someone trying to use the Diner's Club card. And we realised we don't have Diners. So, we get that fixed. Yes, we did get a lot of feedback from customers and our distributors in the beginning, which is good…*
> *(C4T; D, TSF; Extract tc2)*

D → TSF

John from C4T-cl (customer) had similar comments:

> *…Continue and ongoing. Yes, we meet with them on a regular basis about every 3 months after product launched. And we tell them about things we want them to fix, to change, to improve. And then, they come back with ideas, and say, you know, for next version we have this and this. They are very proactive company in that aspect. A lot of stuff in the latest version weren't what we asked for, but things that would make it better…*
> *(C4T-c1; DA, TSF; Extract tc3)*

D → TSF

A → TSF

Ruby from C4T-c3 (customer) also recalled.

D → TSF

> *…The internet voucher has been launched 2 weeks ago in our hotel chains. We've got feedback from customers….Yes, some good, some bad, but constructive. So… we know what we need to change, and work more for that… During these 2 weeks after commercialisation, I guess there is a lot of learning. We learnt what we have to do now; what we still have to improve, and what else we need to learn…*
> *(C4T-c3; DE, TSF; Extract tc4)*

E → TSF

Inter-firm learning with business network partners better equipped C4T to develop their first product that they could sell to more customers. C4T approached their next customer and also a new learning partner, C4T-c2. Gary from C4T-c2 described how C4T approached them…

"What happened was they (C4T) approached my colleague in Edinburgh. And they said to him what they were doing, and they said this could actually work for us, and also what we were doing at the moment, they said we could do it better. (The researcher: How did they do that?) Well, they showed what they did and the benefits from it if we used them…C4T is very good to show what they are doing, what we are doing, and how we could do it better…"

(C4T-c2; PAE, CRT; Extract tc6)

C4T (then a student) transforms to a teacher

Gary was excited to continue how they worked with C4T and how he appreciated the help from C4T…

A → TSF

D → TSF

"… Well, it's, you know, not for us…It's for our 15 chain hotels. We asked them 'would you like to do it?", and we needed to know what to offer? What rule we needed to set up? Then, we need to think about our website, operating procedure…It's very complicated in the very beginning…We almost gave up. I went to C4T and told them about it. They suggested us to form a brainstorming team like a focus group…And we brainstormed the whole process through and identify issues together. It was about 10-15 people, you know, from all the 15 chain hotels. It's a two-way communication. They raised their concerns and what they thought would happen. Some of them we never thought about it before and truly did not know how to solve it. In the brainstorm session, C4T helped us to a great deal. They seemed to have thought about this before and suggested many good solutions. We, including our 15 chain hotel members were very impressed and very satisfied with C4T's performance. I have been in hotel

After TSF → P,A,E → CRT

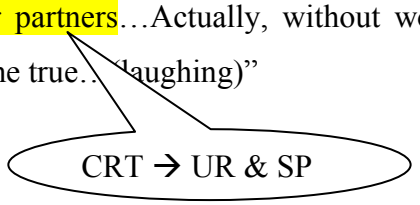
industry for 15 years. They (C4T) definitely are on the top of my supplier list!"

(C4T-c2; DAPE, TSF/CRT; Extract tc7)

In reflecting the whole process of learning with network alliances, Kate (C4T) emphasised its importance on uncertainty reduction and time reduction for their new product development:

"Oh, yes! Most definitely! Without working and learning with our network partners, we would still uncertainty for many things and our idea would just not possible to be developed into a product. It is not from only one partner, it is really the cooperation with all our partners…Actually, without working with them, our dream would never come true… (laughing)"

(C4T; CRT, UR & SP, Extract t1)



Discussion and Summary

Data in this case suggest:

1. Inter-firm learning in business networks is found at all the stages in product development process.

2. The transfer of existing knowledge (TSF) is found important in initiating the product development network learning. Data suggest the effect of the transfer of knowledge is through the accessing, collecting, and sharing of existing knowledge. Data also suggest that, by employing dialogue (D) through meetings, discussions, emails, chatting etc., knowledge is transferred among networked companies in the entire product development process. (see extracts ti1, ti2, ti3, td4, td5, tc4, tc6)

3. Data reveal that for implicit knowledge, employing dialogue is not sufficient for knowledge transfer. Company employs articulation (A) through probing and

asking questions, working with network partners, to turn tacit knowledge into explicit. (see extracts ti2, td1, td4, td5, tc3, tc7)

4. In transferring knowledge, experience (E) is found playing an important role. A high level of expertise with the network partners know-how makes the transfer of knowledge easier as described by the hub company and its spoke (direct and indirect ties) companies (extracts ti1, td1, td2, td3, td4, td5, tc2, tc3).

   Also, C4T generated a product idea from Kate and Ann's experience, that is years of work experience and past learning in hotel sector. Their experience also assists Kate an Ann in transferring knowledge to and from their network partners as John (customer) described. (see extract td3)

   A theme is suggested from the data, this study named it 'pollination' (P). The data suggest that firms benefit from receiving and integrating knowledge transferred from various network partners, in which it helps to develop a better product. In this case, 'pollination' is found in many instances. For example, by the transfer of knowledge, C4T (hub) received and then integrated different knowledge from C4T-c1 (customer #1) and its customer (C4T-c1-1c) so that better (or customer's required) product was developed – 'pollination' is in effect (see extracts ti2, td2, tc7). The pollination effect is also suggested in the case of C4T-s1 (supplier) (see extract tc1, td6)

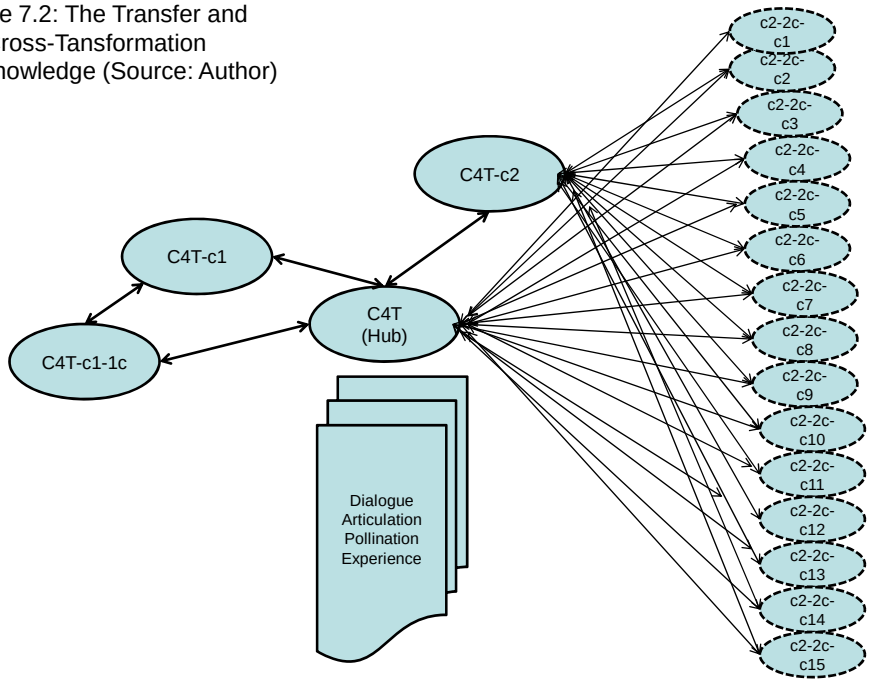
5. By the engagement of 'pollination', this case also reveals another important NPD network learning process, this study names it the 'cross-transformation' of new/advanced knowledge (CRT); To help better understanding the process and the developing of the 'cross-transformation' of new/advanced knowledge, the researcher segments the phenomenon as below (for the purpose of clear explanation, the anecdote focuses on the customers as the main network learning partners)

a. C4T generated a product idea from their experience (or past learning) to search business opportunity.
b. By engaging dialogue, articulation, and experience, C4T learnt from C4T-c1 (Customer #1) and C4T-c1's customer (chain hotel) to screen and develop the idea. Different knowledge is transferred among the hub-company and its network partners.
c. By receiving and integrating different knowledge transferred by various network partners (Customer #1 and its chain hotel), C4T developed the product and shared the advanced knowledge back to C4T-c1 and its chain hotel.
d. When the developed product sold to a new customer (C4T-C2), similar process is in place, and C4T transforms from a 'student' to a 'teacher':
    - C4T's knowledge learnt from 'old' customers (C4T-C1) and its customer C4T-C1-1c) was transferred to 'new' customer (C4T-C2). New customer's (C4T-C2's) knowledge (past learning) was then transferred to C4T (hub).
    - C4T (hub) received and integrated new knowledge from new customer (C4T-C2) and its 15 chain hotels together with its existing knowledge for developing a better (customer required) product – 'pollination' is engaged.
    - Through the integrated knowledge, C4T (hub) developed advanced knowledge and shared back to C4T-C2 and its 15 chain hotels
e. Thus, the process of 'cross-transformation' of new/advanced knowledge takes place:
    - C4T integrated its own knowledge with knowledge from C4T-C1, C4T-C1-1c, C4T-C2, and its 15 chain hotels to develop (or transform) new/advanced knowledge in developing its on-line coupon.
    - C4T-C1 and its customer (C4T-C1-1c) integrated their own knowledge with knowledge from C4T to develop (or transform) new/advanced knowledge in implementing on-line coupon.

- C4T-C2 and its 15 chain hotels integrated their own knowledge with knowledge from C4T to develop (or transform) new/advanced knowledge in implementing on-line coupon.
- Network alliances are under a cross effect of 'student-teacher' transformation. The process of 'cross-transformation' of new/advanced knowledge expands and goes on.

6. In the process of 'cross-transformation', transfer were first occurred, then pollination, articulation and experience were engaged among C4T, C4T-c1, C4T-c1's customers, C4T-c2, C4T-c2's customers (extract ti2, tc1, tc7). C4T won customer satisfaction and gained more knowledge for next NPD project, and of course, more business comes. Figure 7.2 illustrates these effects.

Figure 7.2: The Transfer and the Cross-Tansformation of Knowledge (Source: Author)



7. Finally, data indicate that it is the cross-transformation that helps the uncertainty reduction and speed-to-market in NPD (see t1).

In sum, in exploring how network learning takes place in successful NPD projects, this case suggests that a process of the transfer of existing knowledge (access, collect and share) through firm's engagement of dialogue, articulation, and experience, and the cross-transformation of new/advanced knowledge (receive, develop, and share)

through firm's engagement of pollination, articulation, and experience. The data suggest that the effect of 'pollination' comes from firms receiving and integrating knowledge, which is important engagement for generating new/advanced knowledge. The case reveals a cross effect of student-teacher exchange fostering the cross-transformation of knowledge. The effect of the cross-transformation of knowledge is iterated and expanded in new product development process; more importantly, it is the cross-transformation that impacts on uncertainty reduction and speed-to-market in NPD.

(Case e-Business)

With a PhD degree in technology and years of work experience in IBM (one of the biggest companies in hi-tech industry in the world) Dr. Reed established his own company C2E in 1996. Dr. Reed strongly believed that a company like C2E, specialising in e-business, product development by working with business network partners was the key to his company's success…

Idea Management

In one staff meeting, Dr. Reed emphasised his vision with his management team.

P → CRT

> *"One of the key elements to our successful inno ion lies in our company culture. The culture is NOT an internal matte , but it has to get in place in our entire supply chain! It is a rich 'fusion' approach that makes our company unique – all the combinations mixing into it. It is the culture to work together, listen to each other, and help companies in our supply chain do the same thing. By this way, we all win . . "*
>
> *(C2E; DP, TSF/CRT, Extract ei1)*

D → TSF

Becky, the Marketing Manager echoed Dr. Reed's vision:

D → TSF

> *"I agree! Especially listen to our customers. Customers are fantastic 'leveller'. We had made one big mistake once that we cut off our customers,*

trying to come up new ideas from our own corner. Doesn't Work!! It just doesn't work. We need to listen to customers"
(C2E; D, TSF, Extract ei2)

Alan, the R&D Director, remembered the painful experience:

"Keep Talking!" Alan stressed. "I mean we learn from talking with our customers for what they want and our customers talk to us for what we can do for them. The interaction among people is through talking. Talking is the best way to get our people to learn…"
(C2E; D, TSF; Extract ei3)

D → TSF

Two days later, Dr Reed and Alan were having a conversation about a problem occurred in what Alan said 'keep talking'. Alan vividly described the problem.

A → TSF

"… We all speak English, But the language they (a customer from another industry) use was different from the language we use. And it is very difficult to communicate with them. Client found difficulty understanding us, and we found difficulty understanding client. We didn't know what they really wanted. This understanding issue could be a big mass."

"Is the problem solved?" Dr Reed was worried.

D → TSF

"Oh, yes. We arranged conference calls and several discussions. And we asked them to provide us some blueprints and documents to study. We then sit together in one room and present a power point presentation in what we have done in terms of our understanding of their needs. And they also did a presentation to show the material they have received and what they would do to that material. After two month, an intellectual 'Aha!' clicked. We were really trying hard to understand what they tried to tell us. Eventually, we understood and certainly had an 'aha' moment." Alan answered.

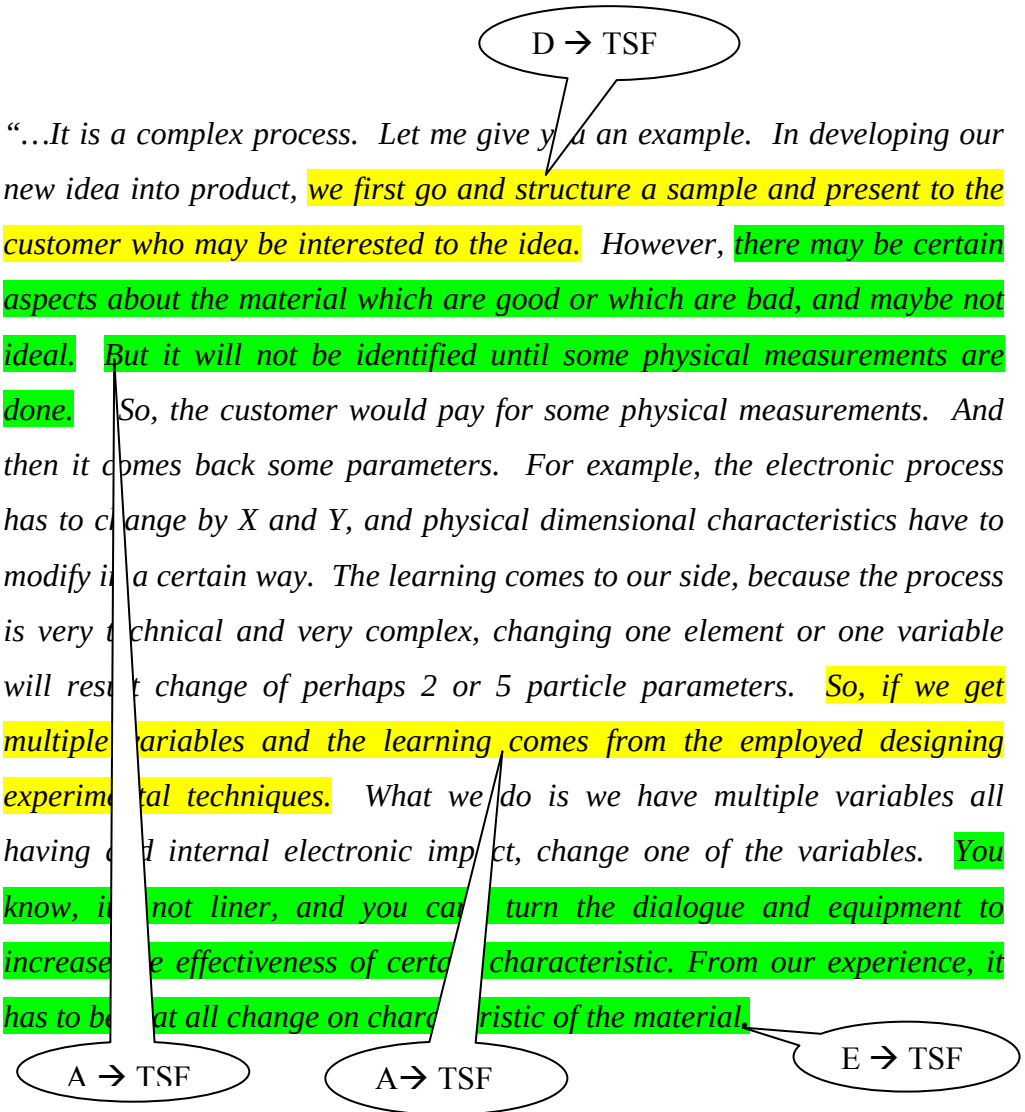
A → TSF

Dr Reed was relieved.

(C2E; DA, TSF; Extract ei4)

Product Development

In developing new ideas into product (or service), inter-firm learning with business network partners was highlighted again, and the process seems complex. Dr Reed recalled:



"…It is a complex process. Let me give you an example. In developing our new idea into product, we first go and structure a sample and present to the customer who may be interested to the idea. However, there may be certain aspects about the material which are good or which are bad, and maybe not ideal. But it will not be identified until some physical measurements are done. So, the customer would pay for some physical measurements. And then it comes back some parameters. For example, the electronic process has to change by X and Y, and physical dimensional characteristics have to modify in a certain way. The learning comes to our side, because the process is very technical and very complex, changing one element or one variable will result change of perhaps 2 or 5 particle parameters. So, if we get multiple variables and the learning comes from the employed designing experimental techniques. What we do is we have multiple variables all having a internal electronic impact, change one of the variables. You know, it is not liner, and you can turn the dialogue and equipment to increase the effectiveness of certain characteristic. From our experience, it has to be at all change on characteristic of the material.

Dr Reed found it was bit of too complex to understand and decided to summarise the key points.

So, what we do is we design equipment, say with 6 variables. Customer agrees to invest. And then we use the design of experiment in order to learn

how to grow material to meet our customer's requirements. This learning not only helps us to win a business but advances our original design that we can sell to our next customer.

(C2E; DAPE, TSF/CRT; Extract ed1)

After TSF
P → CRT

The development process sounded rather complex in transferring technology and know-how. Dr Reed highlight that the transfer of tacit knowledge is a challenge. Tina from C2E-s2 (supplier) had the following comments.

A. E → TSF

"…They (C2E) placed an order for our design. It just did not work well. You can't just give them a book. Because it is also based on the experience and you are transferring, if you like, to a company's engineer…the area we are working is not like 'you take my book, and try to build the circus yourself' it won't work. It's the know-how, the experience that we cumulated over those years by serving many different clients. That's why people pay for that expertise and know-how that is beyond what's in that book…So, we went back to them (C2E) and ran it again and again with them until it worked for them…"

(C2E-s2; AE, TSF; Extract ed2)

A E → TSF

When asked how C2E-c1 (customer) work with C2E and its network partners with the material presented by C2E, Danny from C2E-c1 replied:

D → TSF

"Customers and suppliers are the most critical partners to help us. Customer (C2E-c1-1c) feedback was asked to see where they'd like to improve. Also, our senior management regularly visited our supplier (C2E) to see the progress of the developing products. The purpose is to align everyone to the overall project. To make sure everyone is aware of the stage of the project development. And to align customers to have some inputs and allow C2E to check available technical skills."

(C2E-c1; DA, TSF; Extract ed3)

A → TSF

A culture of inter-firm learning in business networks did exist not only in C2E but also in its supplier chain!

Commercialisation

In launching the new product, Dr Reed shared his experience in how companies were aligned together.

D → TSF

"…Sometimes you have to arrange meetings, maybe have a conference call with all 3 parties (supplier, customer, customer's customer) to get together. You can have a discussion, or you can have an electronic presentation while all 3 parties are all involved…The purpose is to align everyone to the overall project. To make sure everyone is aware of the experience of the new product, and to align end customer to have some input for what they would like to see next. And to accommodate C2E with an opportunity to have the input on whether the product achieved it objective and to resolve any issues they (customer) have. We do learn a lot and help us to improve our next product."

A P → CRT

E → CRT

(C2E; DAPE, TSF/CRT; Extract ec1)

Ian from C2E-c1-1c (customer's customer) described how they tackle complex details in new launched products.

A → TSF

E → TSF

"…Yes, there was some learning occurred at our end when their (C2E-c1) finished product was built up. We went and checked how performance was, what the life time that product was, what the reliability was. That's an on-going learning experience.. What our company would do then, we took the finish process and put them down to the specification and form the manufacturing specification. So, when we are built in this product (from C2E) into our production, for example, we have a control production process, controlled by control document. This control document also recorded our experience. We once used this control document and share with C2E-c1 and their supplier (C2E)…

After TSF; E → CRT

(C2E-c1-1c; AE, TSF/CRT, Extract ec2)

Tacit knowledge Transfer is also a challenge at this stage. Tony from C2E-c1 (customer) had some painful experience.

"…The obstacles occurred with a new invented process. This issue is very complicated. Well, the only way to transfer the technology is regular meetings. Unfortunately, regular meetings achieve nothing until we have the confidence to cross a red line. That is, we work with them (C2E) to see what they are working and play together with the Not until can we play together with them, we don't understand the process

(C2E-c1; DA, TSF; Extract ec3)

D → TSF

A → TSF

Experience and pollination were highlighted many times in this case. Dr. Reed recalled what had happened after the product was commercialised.

AE → CRT

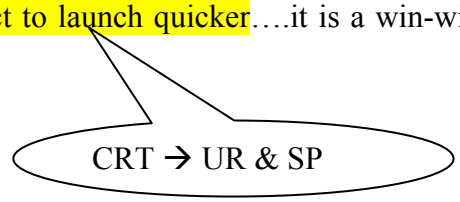
"…After the product launched, job was done and didn't hear anything for sometimes. One day, C2E-c2 (customer) ca back to us. And their approach was 'oh, we know what we did was wrong. It's not your problem. But we got a problem and have no idea how that happened! Can you fix it up for us?' What we found later was they did something wrong, something quit silly in their case. Something like you take a motor car put it into garage and let it over heat, that kind of thing. What we found was on the circus board, they changed where the wiring went. And it was very important where that wiring went. And what we did was to cut what it shouldn't be. And it worked perfectly. It is there because you got the steering wheels; you got to put them in the right place. So, we told the company when you do that kind of thing you are not supposed to change anything, because it will not work; or you'll have problems. This is based on our years of experience. Many customers just made the same mistake. Then, they changed it.

(C2E; APE, CRT; Extract ec4)

PE→ CRT

Finally, Dr Reed was asked how learning with business partners helped uncertainty reduction and speed-to-market, he recalled:

> " As I mentioned earlier, C2E's success is based on a rich 'fusion' culture. It is the culture to work together and to learn together. Today we may be a student to learn from our working partner; tomorrow we may turn to a teacher to teach others what we have learnt. It is this fusion culture helps us to reduce uncertainty and push our product to launch quicker….it is a win-win game…"
> (C2E: CRT, UR & SP; e1)



Discussion and Summary

Data in this case suggest:

1. A culture of learning with network partners, not only in one company but in the entire supplier chain, helps successful product development. This phenomenon is supported by the hub company and its spoke companies in this case (see extracts ei1, ed3, ec2)

2. Inter-firm learning in business networks is found at all stages in product development process.

3. This case suggests that inter-firm learning in product development networks occurred from the transfer of knowledge (TSF) which leads to the cross-transformation of knowledge (CRT). As Dr Reed explained how the successful new product was developed from having customer in investing some physical measurements in which knowledge was transferred in the first place; the transferred knowledge facilitates the customer with better understanding on the new technology and accommodates the hub company to develop a better advanced product. Customer uses the new know-how to upgrade their product for customer's customer; and the hub company uses the transferred know-how to sell a more advanced product and the engagement of 'pollination' is in effect

with new customers. This process is expended and iterated in business networks. The teacher-student exchange effect of the cross-transformation of knowledge is revealed (see extracts ed1, ec1, and ec4). Figure 7.3 illustrates this effect:

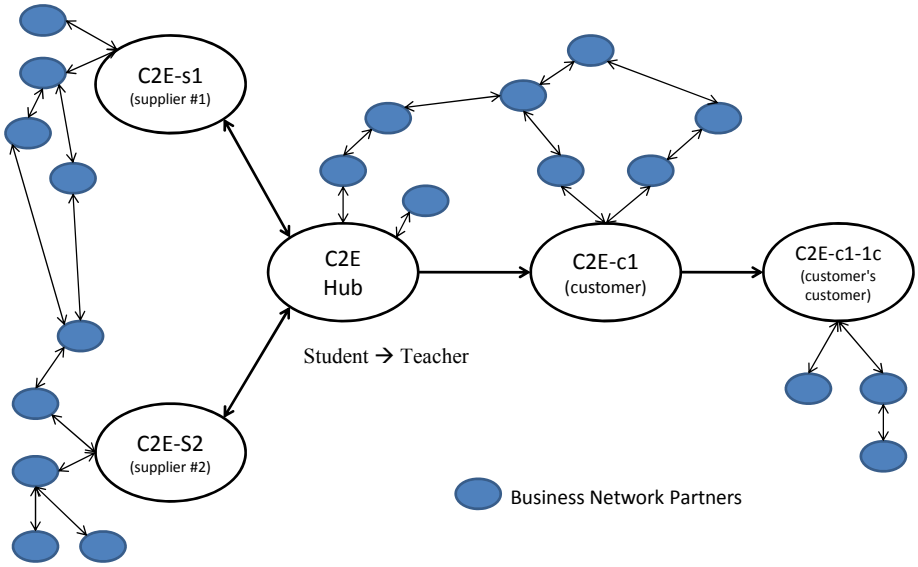


Figure 7.3: Cross-Transformation Effect
(Source: Author)

4. For the transfer of knowledge, the theme of 'dialogue' (D) appeared repeatedly in this case. For example, Becky (marketing manager) highlighted the importance of listening to customers (extract ei2); Alan (R&D director) stressed the need of 'keep talking' (see extract ei3); and Danny (customer) always asks for feedback (extract ed3).

5. This case reveals that employing 'articulation' (A) is critical for both the transfer and the cross-transformation of knowledge. For example, due to different industry, different communication style, Alan found client and the company (C2E) have difficulty understanding each other; and uses various methods (such as studying client blueprints, intensive discussions with experienced people) to help the transfer of knowledge (see extract ei4). Also, Tina (supplier) believes that in the transfer of knowledge, you *'can't just give them a book…we went back and ran it again and again with them (C2E) until it worked for them' (*see extract ed2).

This is an important process for the cross-transformation of knowledge. The knowledge is shared from supplier (C2E-s1)'s network partners and became tacit knowledge (i.e. not understandable for C2E). When C2E work with its supplier (C2E-s1), engaging articulation is necessary to turn tacit knowledge into explicit knowledge that facilitates to create advanced knowledge and pollinating to other network partners. Thus, articulation plays a critical role in the cross-transformation of knowledge.

6. This case suggests that the engagement of pollination (P) accommodates the process of the cross-transformation of advanced knowledge. For example, in explaining how product is developed, Dr Reed (C2E) highlighted they received and integrated knowledge learnt from existing customer (the one paid the bill) with their existing knowledge (gain from the previous knowledge transfer) , developed the product first for the existing customer, then would sell to new customers, in which another effect of pollination would be activated.

7. The case suggests that 'experience' (E) is important for both the transfer and the cross-transformation of knowledge. Because of C2E-s2 (supplier's) rich experience and expertise, knowledge is transferred and cross-transformed easier among its supplier, C2E, and C2E's future supplier or customers (see extract ed2); among C2E, C2E-c1 (customer), and C2E-c1-1c (customer's customer) (see extract ec2); among C2E, C2E-c2 and C2E's future customers (see extract ec4).

8. Data highlight that the cross-transformation helps the uncertainty reduction and speed-to-market (see extract e1)

In sum, the data from case e-business suggests the transfer (access, collect, and share) of existing knowledge and the cross-transformation (bring back, develop, and share) of advanced/new knowledge from different network partners are taken place when firms learn about product development in their business networks. The data suggest that knowledge has to be transferred before transformed into advanced knowledge; thus, new/advance knowledge is developed from the transferred existing

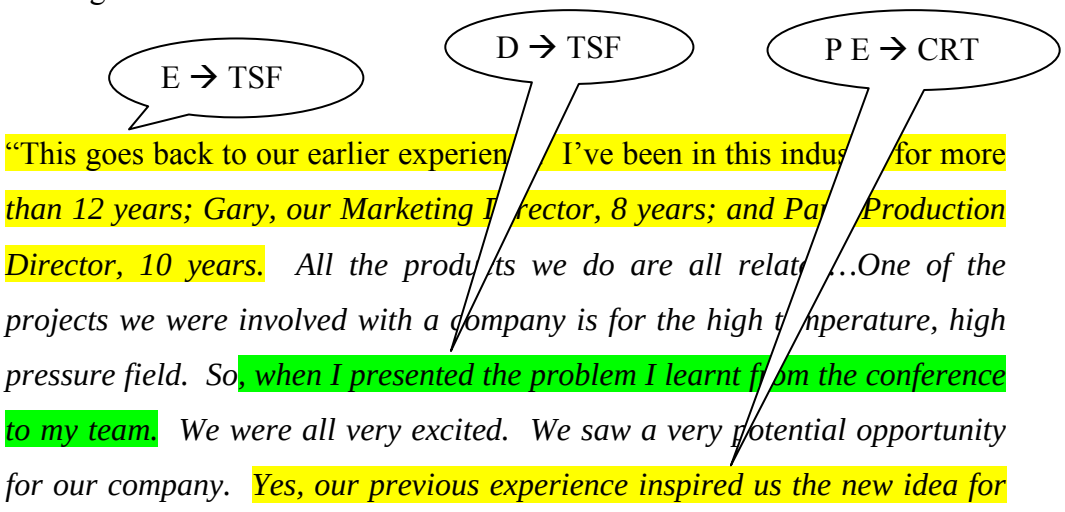
knowledge and is shared for better new product development. For the transfer of knowledge, companies are found to employ dialogue, articulation and experience. For the cross-transformation, in addition to articulation and experience, 'pollination' is always in effect for firms integrating existing knowledge received from different business network partners. Finally, the data of this case uncovered that NPD network learning (by the process of the transfer and the cross-transformation) is expended and iterated through an effect of student-teacher exchange among all different kind of allied partners (direct or indirect) in firm's business networks, which enhances the effect of 'cross' in the process of knowledge transformation in NPD network learning. Finally, data highlights that it is the cross-transformation that helps uncertainty reduction and speed-to-market.

(Case Oil)

It was a summer afternoon in Aberdeen, Ray, Managing Director of C5O, was sitting in an annual conference for oil industry, thinking about a problem just raised by Shell and BHP Billiton, two big petroleum providers. The problem was about a seal for drilling equipment. He was very excited because it looked like nobody knew how to solve the problem, but he and his team might do…

Idea Management

Ray brought back the problem and started work with his team. Ray recalled how the new idea was generated.



"This goes back to our earlier experien[illegible] I've been in this indus[illegible] for more *than 12 years; Gary, our Marketing D[illegible]rector, 8 years; and Pa[illegible] Production Director, 10 years.* *All the produ[illegible]ts we do are all relat[illegible]…One of the projects we were involved with a company is for the high t[illegible]mperature, high pressure field. So, when I presented the problem I learnt f[illegible]om the conference to my team. We were all very excited. We saw a very potential opportunity for our company. Yes, our previous experience inspired us the new idea for*

this product (the studied successful product development projects). Because we know the industry, when we came with solution (product idea), we've already had an idea where we could use it, and which problem it overcame. And then, I went and prepared a presentations, or documentation, equipments which explained why this was a good solution for their problems. And then, I went to companies like the Shell, the BP, or whatever. I went and spoke to them. I say, 'Hey I know you have problem in this well, because high temperature, how pressure. So, here we have a real to overcome your problem. And we checked their response…."

D → TSF

(C5O; DPE, TSF/CRT; Extract oi1)

Ray believed that on-going communication is a key for idea management…

"…Let's put this way… the interaction among companies in the oil industry is quite high. Because the on-going communications, because the relationship (everybody knows everybody), we always discuss issues with them, our customers, suppliers and even our competitors over the developing process. And that way you can learn some lessons plus avoid big mistakes at the end…"

D → TSF

(C5O; D, TSF; Extract oi2)

In screening product ideas, understanding details was highlighted. Andrew from C5O-jv1 (joint venture) suggested a hands-on approach.

"It's the technology transport learning task. You have to be there, on-site, hands on! It's individual to individual. If you want to understand this technology, you do need to involve people who do understand it. And you need to either touch it, or at least understand how they are going to the process, and how they are developed. You don't know the details until you actually get involved. This is why the companies who want to support the project insist to champion the project."

A → TSF

(C5O-jv1; A, TSF; Extract oi3)

Product Development

Paul, Production Director reflected how they worked for some areas they did not specialised in product development – they involved supplier right from the start!

D → TSF

A → TSF

"…What we generally d s we come up with an ov ll idea for what we need to do, and in so e particular area we don't h ve knowledge on, say, motors. We don't develop electric motors. We h ve the solution by using electric motors. We, then, go and ask them to work with us to provide electric motors, part of the answer…And we say, 'here is the problem; here is the solution we come up with. And we need the technology and knowledge from you for our solution.' And we presented that in a meeting or send them our requirements to this…We involved supplier right from the start. And they came up the solution that our customer wants…and then, we gain that knowledge for next project…"

(C5O; DPE, TSF/CRT; Extract od1)

D → TSF

P → CRT

Rick from C5O-s2 (supplier) echoed what Paul described.

D A → TSF

E → TSF

"We always work for our clients' product prototype, and we w ld like to be involved early on. We know how to do and what they want. C5O would come to us with their drawing, but because we are not only manufacturing but we are also engineering plant as well, we knew all the key people in the industry. We don't do, say, 'here is the prototype, gives us the price'. We involve more than that. And again, we know the technology and the people, and provide them the best solution to them. So we meet them (C5O) day after day, and regular communication, we provide the best solution and the product, at the right price, and at the right time. …So, through the communication, discussion and on-going adjustment, and that include how to do the job more efficiently and quicker. Now, I am assuming that when we

have similar task or job in the future, we will have better experience to do a better job."

(C5O-s2; DAPE, TSF/CRT; Extract od2)

After TSF; P E → CRT

Lisa from C5O-s1-2s (supplier's supplier) shared his experience working with C5O.

E → TSF

"…Yes, it may fail, and it fails because of X, then, fixes the X, and it works. And it does improve it (the new product) as well. So, you are learning, you learn from the track record and you learn from trial and error. That happens and works… And that's what we are trying to do in this technology. You won't get to know the solution right away and know this possibly makes this well work. And in fact, you learn what does work, what doesn't work. You proof it. There is a lot of learning around that trial.

(C5O-s1-2S; AE, TSF; Extract od3)

A.E → TSF

How did C5O work with customer? Bill from C5O-c2 (customer) shares his experience.

A → TSF

"Well, again, there are two different products. For seal, that's different kind of… yes, we'll run for simulation test before we fully run it…For the built one, we take it to the oil wells, and test it. We run it in the test well, then, we run it to a full cycle, and operational cycle. So, we can measure the pressure test internally and to decide if there is any causes to be bad to run in the pipe. And the pressure test internally will see the sort of functions. We come to groups, then, we come to pressure test again. Then, we go together the test and we go and look at it…CO5 will do this test for us. They will do this test in-house for us. We will send somebody to Aberdeen to test. Or we'll use some people who based in Aberdeen to do this test. We involve all the related parties…This works well, and both of us learn from each other a lot."

(C5O-c2; DAP, TSF/CRT; Extract od4)

D → TSF

After TSF
P → CRT

Commercialisation

After months after months hard work, the product finally was good enough to present to customer, Henry from C5O-c1 (customer) recalled.

> *C5O is a company which recently phoned us that they've got some special product starts the market. And we know people from C5O, because they previously worked for other companies which provided services equipment and tools…So they came and showed us the product they developed. We are eventually the customer for this product…We learn new technology from them (C5O)… And we want to drill our wells deeper where temperature is a problem. The temperature is high, the pressure is high. So, all the time, we are setting the equipment suppliers new challenges to exceed what they have done before. And C5O did it! We are using their product and no problem occurred so far…*
> *(C5O-c1; AEP, CRT; Extract oc1)*

PE→CRT
C5O transform from student to teacher

AE→ CRT

For commercialisation in oil industry, Ray shared his experience.

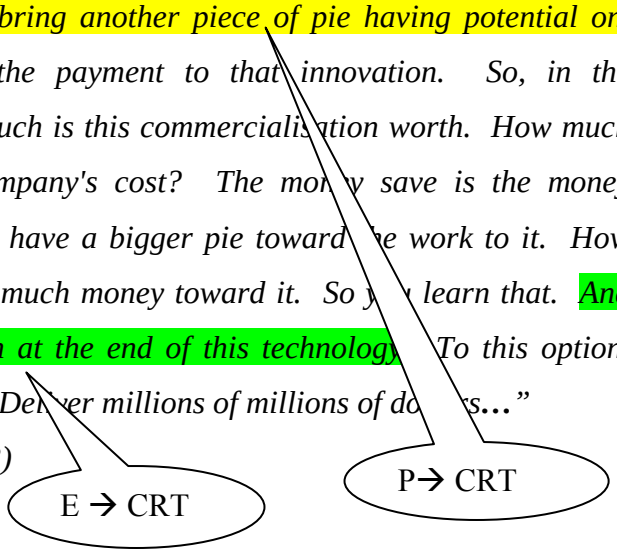
D→ TSF

> *…No. It is just the way the industry is developed. If you want to sell a product, you have to tell them all the details before they can use it. Because the cost of oil is so high, risk for something we are not comfortable about is so high. It triples the reluctance to use a new product. One fully understands and conceives the full benefit to using them, and being confident that it's going to work. So, the only way to do that is that you have to educate your customer and convince you have done the work; you have done the research. You should be fully qualified to the requirements. Otherwise, customers are going to do themselves, because the variables are very cautious about the cost and the risk.*
> *(C5O; DA, TSF; Extract oc2)*

A → TSF

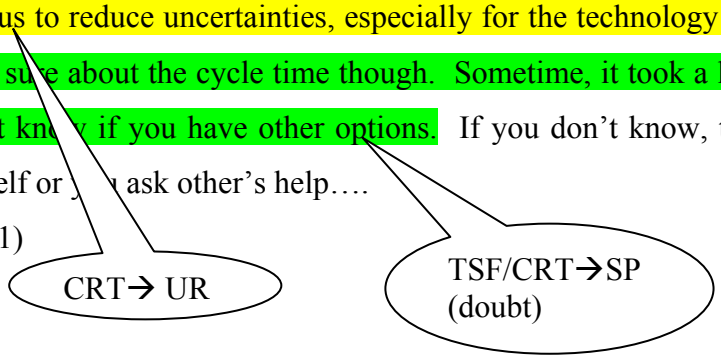
Ray continued.

The question is what is actually this commercialisation delivered? What is the dollar associated from this technology? Is it possible we get the dollar from this technology? So the whole commercialisation process, there is a lot to learn. At the end of day, this is the alternative of different pieces of pie. What you got there is you bring another piece of pie having potential on. How much you will get the payment to that innovation. So, in the commercialisation is how much is this commercialisation worth. How much is it going to save the company's cost? The money save is the money generated, because you can have a bigger pie toward the work to it. How much money you save, how much money toward it. So you learn that. And you also learn what happen at the end of this technology. To this option, what I might get from that? Deliver millions of millions of dollars…"
(C5O; PE, CRT; Extract oc3)



Finally, Ray (C5O) was asked to reflect the impacts of learning in business networks in reducing uncertainty and cycle time in NPD:

"…we learnt a lot from our alliances…to combine what we learn with our years of experience that did help us to reduce uncertainties, especially for the technology and for the market. I am not sure about the cycle time though. Sometime, it took a long time to learn, but I don't know if you have other options. If you don't know, then you either find out yourself or you ask other's help….
(C5O, CRT, UR & SP; o1)



Discussion and Summary

Data in this case suggest:

1. Oil industry is a mature and well established industry. This case suggests that experience (E) plays an important role in the transfer (TSF) and the cross-transformation (CRT) of knowledge in product development. For example, Ray (C5O) and his team's experience in oil industry not only inspires them to

generate a new product idea, works better with network partners (e.g. C5O-c1 customer) in developing products, but also experience is learnt and saved when product is commercialised. The saved experience is then ready to be transferred for next product development project and the company transforms from a student to a teaching (see extracts oi1, oc1, oc3).

The data also suggest that company employed experience to transfer knowledge that learnt from the previous work with previous business partners, to present work with present network partners. In this process, new/advanced knowledge is created and shared among the network partners, and eventually becomes new experience that is saved for next project. The cross-transformation of knowledge is thus in the process.

2. Dialogue (D) is highlighted in this case. For example, Ray (Managing Director) emphasises the importance of on-going communication with network partners in extract oi2. Paul (Production Director) recalled that when they needed some solution in developing product, they *'go and ask'* supplier to have meetings and send them requirements (extract od1). In the transfer of knowledge, companies employ dialogue (see extracts oi2, od1, od2, oc1, oc2)

3. Articulation (A) is found in several interviews. In transferring tacit knowledge or know-how, how to turn tacit into explicit is important. For example, in the interview with C5O's joint venture, Andrew mentioned that in '*transporting technology'* , company needed to be on-site, hands-on and involved people who did understand it (see extract oi3). Richard from C5O-s1 (supplier) shared their experience of trial and error to turn tacit knowledge into explicit (extract od3).

4. Firm's engagement of 'pollination' (P) is found important in the cross-transformation of knowledge. The data in this case provide an explanation to the relationship among pollination, experience and the cross-transformation of knowledge. An important link comes from C5O management team's rich industry knowledge. The team's rich industry knowledge is gained from the

engagement of pollination (receiving and integrating) from working with different network partners in previous NPD projects. It is cumulated as 'experience', and is used in their new product development project. This is first layer of cross-transformation (see extract oi1). When their new developed product (metal-to-metal seal) is commercialised, advanced knowledge is shared through working with network partners (e.g. supplier and customer). Knowledge is integrated and shared between C5O and its network partners (e.g. JV). The new/advanced knowledge then turns to experience and ready to be shared in next product development projects (see extract oc3).

5. Data indicate that through different knowledge combining (cross-transformation effect) uncertainty reduction is improved. However, network learning takes time; data reveal some doubt if network learning helps speed-to-market.

In sum, for inter-firm learning in product development networks, a process of the transfer of knowledge (access, collect, and share existing knowledge), followed by the cross-transformed of knowledge (bring back, develop and share new/advanced knowledge) is suggested. The themes of dialogue (D), articulation (A), pollination (P), and experience (D) are repeated appeared in this process. The data suggest that dialogue, articulation and experience are used often for the transfer of knowledge; and pollination (receive and integrate knowledge), articulation and experience are used for the cross-transformation of knowledge.

This case highlights the importance of 'past learning' and indicates that the cross-transformation of knowledge (CRT) can be multi-layers. That is, the new/advanced knowledge that firms obtained from the previous NPD co-projects, becomes the existing knowledge for the present NPD projects. This 'new formed' existing knowledge then integrated with received knowledge from different network partners ('pollination' is in effect), and more advanced knowledge is developed and shared. The first layer of the cross-transformation is thus in effect. The more advanced knowledge cross-transformed from the present product development co-projects is cumulated. Moreover, the 'present' advanced knowledge will become the 'next' existing knowledge and ready to be pollinated for next layer of the cross-

transformation of knowledge. A cross-effect of student-teacher exchange is beyond time constrained. Figure 7.4 illustrates this concept.

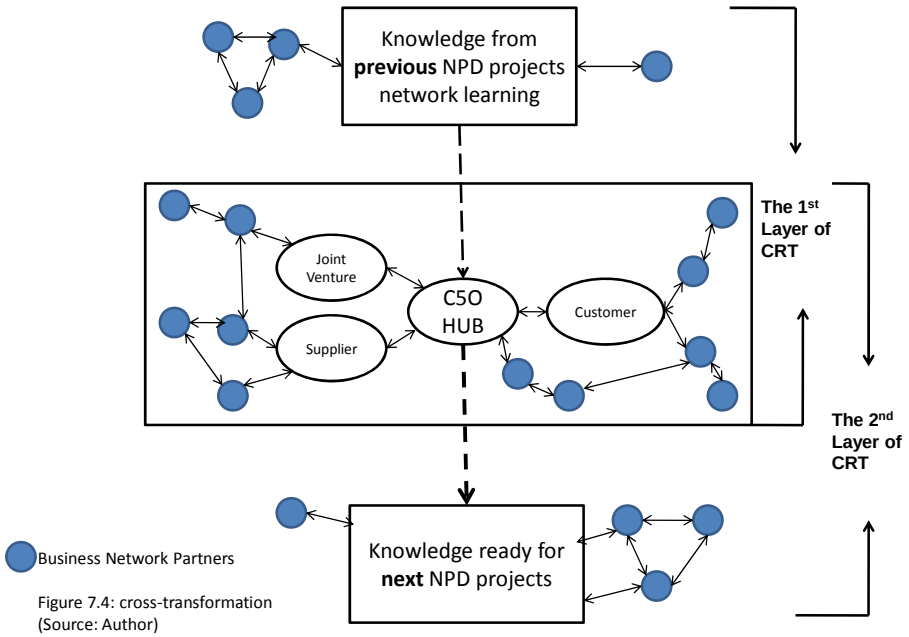


Figure 7.4: cross-transformation (Source: Author)

Cross-Case Patters and Propositions

To understand the phenomena beyond each individual case, the researcher searched for cross-case patters. In searching for the pattern, the researcher employed the 'constant comparison' suggested by Miles and Huberman (1994) and 'counting' technique suggested by Miles and Huberman (1994) was used to judge 'important' or 'significant' or 'recurrent'. Table 7.7 summarises the cross-case patters by comparing findings in three cases. Table 7.8 shows the counting results of the patters found in three cases. Details and the extant literature are discussed as below.

Cross-Case Patters	Description
TSF --> CRT	1. Companies learn about NPD in their business networks by a process that consists of the transfer of existing knowledge. and the cross-transformatin of advanced knowledge. 2. The more the transfer is the more the corss-transformation will be.
D --> TSF	Companies engage dialogue for the transfer of knowledge in NPD network learning.

A --> TSF	Companies engage articulation for the transfer of knowledge in NPD network learning.
E --> TSF	Companies engage experience for the transfer of knowledge in NPD network learning.
P --> CRT	Companies engage pollination for the cross-transformation of knowledge in NPD network learning.
A --> CRT	Companies engage articulation for the cross-transformation of knowledge in NPD network learning.
E --> CRT	Companies engage experience for the cross-transformation of knowledge in NPD network learning.
CRT --> UR	In the network learning process, the cross-transformation helps NPD uncertainty reduction.
CRT --> SP	In the network learning process, the cross-transformation helps NPD speed-to-market

Table 7.7: Cross-case Patterns (Source: Author)

Counting Table - Patterns

(The number of interviewees whose statement affirm/imply the coded corresponding concept)

Cross-Case Patterns	Case Oil	Case Tourism	Case e-Business
TSF --> CRT	11	13	12
D --> TSF	10	13	11
A --> TSF	9	13	13
E --> TSF	13	8	6
P --> CRT	5	9	8
A --> CRT	11	12	9
E --> CRT	11	3	4
CRT --> UR	10	11	9
CRT --> SP	3	10	8

Table 7.8: Counting Table - Cross-case Patterns (Source: Author)

Product Development Network Learning

The data in three cases suggest companies learn about product development in their business networks by a process that consists of (1) the transfer of existing knowledge and (2) the cross-transformation of developed knowledge. In this study, the 'transfer' of knowledge stresses the effect of assessing, collecting, and sharing of the existing knowledge in NPD projects. This effect is repeatedly found in three case

studies. The 'cross-transformation' of advanced knowledge, which is repeatedly found in three case studies, depicts the phenomena of firms bringing back, developing, and sharing the newly gained knowledge with network partners, through which companies transforms from a student to a teacher in the network learning.

In the case of Tourism, the data of the case provide empirical evidence of the network learning process and fir's engagement in successful NPD. Existing knowledge was first transferred between C4T (hub), and its first customer (C4T-c1), and between C4T (hub) and its customer's customer (C4T-c1-1c). The existing knowledge was then cross-transformed into advanced knowledge for developing a better product. This network learning process is repeatedly occurred when C4T (hub) co-develops a new product for and with its second customer (C4T-c2). In the case e-Business, the effect of the 'cross'-transformation of advanced knowledge in network learning process is enhanced. C2E as a learning hub, existing knowledge was transferred from two suppliers (C2E-s1 and C2E-s2); advanced knowledge was developed by the integration of different knowledge. The advanced knowledge was then shared to its customer (C2E-c1) and its customer's customer (C2E-c1-1c). This process is expended and iterative in the entire NPD network. In case Oil (C5O), the key of the 'cross'-transformation of knowledge is highlighted by multi-layer effect among the past, the present, and the future NPD projects. The data revealed that knowledge not only can be cross-transformed from network partners in the 'present' projects, but also can be cross-transformed from network partners in the 'past' projects and would further be cross-transformed with network partners in the 'next' NPD project.

The transfer (accessing, collecting, and sharing) of existing knowledge suggested in this study coincides with contentions in the literature. In the inter-firm learning literature, the process of accessing, assimilating and disseminating knowledge are repeatedly highlighted (Cyert and March 1963; Daft and Weick 1984; Cohen and Levinthal 1990; Inkpen 2000). The transfer of knowledge has been viewed as the centre of the organisational processes between a parent company and its alliances (Inkpen 1996; Marsh and Stock 2003).

The cross-transformation of knowledge, on the other hand, is an important finding suggested by this case study. Nevertheless, it is still an under-researched area and is hardly to find a theory to explain this phenomenon well enough. Beamish and Berdrow (2003) has suggested a learning process includes transformation that creates new knowledge and harvesting that new knowledge transfer back to firms. Beamish and Berdrow (2003) contention contributes to the inter-firm knowledge transformation, yet it does not go further to explain the phenomenon from a business network perspective. Marsh and Stock (2003/2006) have claimed that companies may incorporate capabilities from past product development into future projects, and it is in evidenced by Case Oil in this study. Nevertheless, Marsh and Stock's proposal failed to catch the element of the co-transformation effect found in this study. In this study, the cross-transformation of knowledge highlights the effect of network learning developed among different network partners by a student-teacher transformation practice of giving and receiving knowledge in the embedded relationships.

In short, the iterative transfer of existing knowledge among network partners enhances the developing of the advanced knowledge; and through continuous receiving and integrating existing knowledge (pollination effect), new/advanced knowledge is developed and shared among firm's NPD networks. The cross-transformation of advanced knowledge for new product development is thus in effect. In presenting the phenomena suggested by the case study, this study proposes its first proposition:

> ***Proposition 1:***
>
> Companies learn about product development in their business networks by a process that consists of (1) the transfer of existing knowledge (access, assimilate, and disseminate) and (2) the cross-transformation of advanced knowledge (receive, develop, and share); and the more the transfer is the more the cross-transformation will be.

Dialogue, Articulation, and Experience
For The Transfer of Knowledge

The case study data suggest that companies apply dialogue, articulation and experience for the transfer of knowledge in product development network learning.

(Dialogue)

Dialogue (D) for the transfer of knowledge is found repeatedly in three cases. For example, for the transfer of knowledge, in case tourism, meetings, discussions, emails chatting were frequently found (extracts ti1, td4, tc4); In case e-business, 'listen to customers' (extract ei2), 'keep talking' (extract ei3), 'ask for feedback' (extract ed3) were highlighted; and in case oil, 'on-going communication' (extract oi2), 'go and ask' (extract od1) were employed.

This finding echoes Isaacs (1993) contention that 'creating conversations' is critical for learning. Also, Schein (1995) has stressed that we need dialogue to communicate in groups. In inter-firm learning in business networks, dialogue is the key element in that it stimulates network partners to think together (Romme and Dillen 1997; Nonaka and Toyama 2002; Issacs 1993).

(Articulation)

Articulation (A) is another repeated theme appeared in three cases. Data suggest that, in developing projects, tacit knowledge is always a challenge in the transferring process among network partners. Data also reveal that companies employ articulation to turn tacit knowledge into explicit knowledge for the transfer of knowledge. For example, in case tourism, through probing and asking questions and through working with network partners (extracts ti2, td1, tc3), tacit knowledge becomes explicit knowledge that is easier to transfer among product development network partners. In case e-business, companies use blueprints, discussion with experienced people and trial and error methods to understand and transfer tacit knowledge (ei4, ed2). In case oil, on-site, hands-on, and trial and error are used for

the transfer of knowledge (extracts oi3, od3). These findings support the conclusions from literature.

In the literature, the transfer of tacit and explicit knowledge has drawn many scholars attention (e.g. Nonaka and Toyama 1994-2005; Holmqvist 1999; Hedlund 1994). A group of scholars have contributed to some suggestions in better knowledge transfer (von Hippel and Katz 2002; Inkpen 1996; Chanal 2004). Applying articulation by using blueprints, talk to experienced people, etc., companies are able to transfer tacit knowledge.

(Experience)

Experience (E) is found an important theme in the transfer of knowledge. For example, for the better transfer of knowledge, in case tourism, a high level of expertise with the network partners know-how is highlighted (extracts ti1, td1, tc2); in case e-business, 'rich experience and expertise' is viewed as important (extracts ed2, ec4); and in case oil, the company's previous industrial experience accommodates an easier knowledge transfer in the present product development project (extract oi1, oc1, oc3). The literature in studying experience supports these findings. Levitt and March (1988) claim that learning requires experience. Pyka (2002) argues that without a common knowledge base and shared experience, a simple know-how transfer is not possible. Indeed, not only does the transfer of knowledge need shared experience as a base, but also experience facilitates the transfer of tacit knowledge (Moenaert and Souder 1996).

Data suggest that in the transfer of knowledge, dialogue, articulation and experience are applied by the business network partners in product development projects. This study presents the second proposition:

> ***Proposition 2***
>
> In the product development network learning process, companies engage dialogue, articulation and experience for the transfer of knowledge.

Pollination, Articulation, and Experience
For the Cross-Transformation of Knowledge

Data of this study suggest that the cross-transformation of knowledge is an important process in NPD network learning. Data in three cases suggest that companies apply pollination (P), articulation (A), and experience (E) in the cross-transformation of advanced knowledge.

(Pollination)

Pollination (P) is a term suggested by this study to depict firms' behaviour of receiving and integrating knowledge in NPD projects. Pollination is an important phenomenon to cultivate the cross-transformation of knowledge in product development network learning. In the case Tourism, C4T, through the transfer of knowledge from suppliers, customer #1 and distributor, establish advanced knowledge to develop a better product. When the developed product sells to customer #2, firm's engagement of 'pollination' is in effect (extracts ti2, td2, tc1, tc7). In the case E-business, similar phenomena are observed. Dr Reed from C2E explained that they used knowledge learnt from and existing customer (the one paid the first investment), knowledge was transferred from the first customer to C2E, and then the product was developed and sold to the next customer. In this process, C2E engages 'pollination' to integrate its own knowledge with knowledge from suppliers, the first customer, and eventually the new customers (extract ec4).

The engagement of 'pollination' suggested from the case Tourism and the case E-business is a 'horizontal' effect in that knowledge is integrated in the premises of one (or related to) product development project. The case Oil reveals the pollination effect can be 'vertical', in that the knowledge learnt in other project is integrated to the present project and will be integrated into next product development project. In case oil, because of the transferred knowledge in their previous job, three managers in C5O were able to develop a new product that market needed. In this case, C5O

pollinated the transferred knowledge from the previous job to the present job (a vertical effect). In the present job, horizontal pollination was in effect, in that knowledge was transferred from network partners (e.g. supplier) and pollinated to C5O's customers. The advanced knowledge was expected to transfer to next job (or product development project) and continued the pollination effect (extract oi1, oc3). Both vertical and horizontal engagements of pollination emphasises the effect of 'cross' in the knowledge transformation process. In this regard, this essential dynamic property of NPD network learning lies in an evolutionary manner between knowledge as well as organisational boundaries.

In the literature, the concept of pollination is still an under researched topic with a few exceptions. For example, 'integrative practice' raised by Marsh and Stock (2006) stresses the integration of knowledge developed in prior NPD projects and 'Cross-fertilisation effects' proposed by Pyka (2002) describes the fusion of different technological capabilities in innovation networks are a few contentions that close to the 'pollination' found in this study. This study suggests that companies engage 'pollination' to integrate different knowledge collected from different network partners and share with different network partners and the effect can be horizontal (in one NPD project) or vertical (in different NPD projects). Figure 7.5 illustrates this construct.

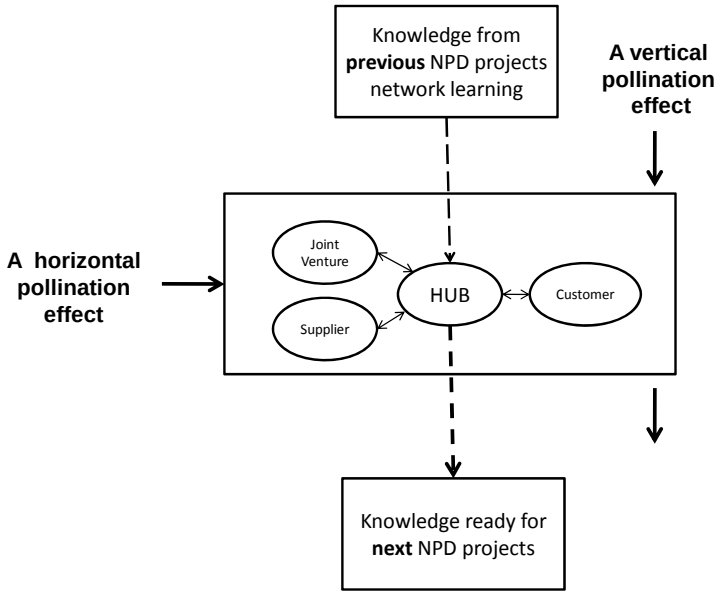


Figure 7.5: Pollination Effect (Source: Author)

(Articulation)

The data also suggest that companies engage articulation (A) in the cross-transformation of knowledge. Similar to the transfer of knowledge, tacit knowledge challenges companies when the cross-transformation of knowledge is in effect. Articulation for the cross-transformation is more complex than that for the transfer of knowledge. By applying articulation, companies build up the 'shared code' to integrate diversified knowledge (Grant 1996; Beeby and Booth 2000) and to better manage tacit and explicit knowledge.

In case tourism, C4T and customer #1 made efforts to turn tacit knowledge into explicit in develop product from knowledge transferred from customer #1 and its customers (extract ti2). The advanced knowledge became tacit and saved in C4T. When developed product sold to customer #2, the tacit knowledge was 'articulated' into explicit again in order to pollinate to customer #2 and its 15 chain hotels (extract tc7). Similar situation was found in case e-business. C2E worked together with its customer #1 and supplier to turn tacit knowledge into explicit that a successful product was developed. The advanced knowledge then became tacit and saved in C2E. When the developed product sold to next customer, C2E and customer #2 worked together to made tacit knowledge into explicit (extracts ei4, ec4). In case oil, tacit knowledge from the previous job was saved in C5O and turned into explicit for their successful product development project and pollinated to their business network partners (extract oi1). At the same time, the knowledge became more advanced and tacit by working with network partners. The tacit knowledge is saved in C5O ready to turn into explicit for next pollination (extract od2, oc3).

In the literature, the concept of 'ba' suggested by Nonaka and Konno (1998) is better reflecting the phenomena of 'articulation' found in three cases. The concept of 'ba' explains the knowledge turning between tacit and explicit by a process of socialisation, externalisation, combination, and internalisation (Nonaka 1994; Nonaka and Toyama 2005).

(Experience)

Experience (E) is also found in the cross-transformation of knowledge. Data of case study indicate that when knowledge is integrated in business networks, it becomes advanced (turns tacit too) and is saved. The saved advanced knowledge then turns into experience. Empirical evidence suggests that learning actors apply the saved experience for next knowledge integration and development. In case tourism, both Kate and Ann's (from C4T) work experience in hotel industry accommodates them in the cross-transformation of knowledge from supplier and customer #1 to distributor and customer #2 and its 15 chain hotels (extract ti1, ti2, tc7). The advanced knowledge became advanced **a**nd was saved in C4T as experience. C4T applied this advanced experience for next activity in the cross-transformation of knowledge.

Data indicate similar phenomena in case e-business and case oil. In case e-business, experience was saved and cumulated in C2E after working with the supplier #1 and customer #1 (extracts ed1, ec1). C2E then applied this cumulated experience when working with supplier #2 and customer #2 (extracts ed2, ec4). Experience accommodated the effect of pollination and the process is continued and iterative. In case oil, experience was the base in the entire product development process. C5O's previous experience generated the new product idea (extract oil). In this case, we saw a continued and iterative process of this experience effect in the cross-transformation of knowledge, that is, experience is engaged from previous to present to future product development projects. This effect is way beyond inter-firm learning. It is an effect in business network learning.

In the learning literature, experience has been well studied on both its positive and negative effects to learning (e.g. Levinthal and March 1993; Powell 1998; Ingram 2002; Sinkula 2002). Powell (1998) has argued that knowledge facilitates the acquisition of more knowledge that highlights experience is required in network learning. Ingram (2002) also concludes that companies need the right type of prior knowledge to benefit from new knowledge presented by their environments. However, the 'unlearn' theory (Levinthal and March 1993; Sinkula 2002) posits

negative view on experience and suggests that past experience inhibits new learning. Conflict is found between qualitative data and the literature. The researcher decided to verify this finding through quantitative research.

The data suggest that in the cross-transformation of knowledge, pollination, articulation and experience are applied by the business network partners in product development projects. This study presents the third proposition:

> ***Proposition 3***
>
> In the product development network learning process, companies engage pollination, articulation, and experience for the cross-transformation of advanced knowledge.

Product Development Networks Learning
For Uncertainty Reduction and Speed-to-Market

New product development has been viewed as a process of uncertainty reduction (Beckman et al. 2004; MacCormack et al. 2003; Tatikonda et al. 2001; Souder et al. 1998; Souder and Moenaert 1992). To cope with rapid changing and uncertainty in product development, firm's ability to create, transfer, assemble, integrate and exploit knowledge assets is essential. These phenomena have been observed and discussed in the literature (Souder and Moenaert 1992; Souder et al. 1998; Daft and Weick 1984; Slater and Narver 1995; Cohen and Levinthal 1990; March 1991; Sinkual et al 1997). Nevertheless, how the inter-firm learning in product development networks impacts on the uncertainty reduction is not clear. Data from three cases highlights that the transfer of knowledge is not sufficient; it is the cross-transformation of knowledge that impacts on the uncertainty reduction in NPD (see t1, e1, o1). This study proposes that companies learn about product development in their business networks by a process of the transfer of knowledge and the cross-transformation of knowledge. Knowledge has to be transferred before it can be cross-transformed. The study argues that in business network learning, it is the

cross-transformation of knowledge that leads to the uncertainty reduction in new product development. The study presents its fourth proposition:

> ***Proposition 4***
>
> In the product development network learning process, the cross-transformation positively contributes to the uncertainty reduction for product development.

Moreover, speed-to-market in new product development has drawn many researchers' attention and contributing a large number of academic papers (Griffin, 2002; Filippini et al. 2004; Appleyard et al. 2006; Duysters and Man 2003; Menon et al. 2002; Eisenhardt 1989; Crawfrod 1992). Much of the literature has argues that companies work with business network partners to expedite the speed-to-market for a new product (Rindflieisch and Moorman 2001; Crawford 1992; Eisenhardt and Tabrizi 1995). . Data from three cases indicates that the cross-transformation helps the speed-to-market in NPD, except there was some doubt from the case of oil. The researcher decided to examine it by the survey research. In testing how the proposed product development network learning process impacts on speed-to-market, this study proposed the fifth proposition:

> ***Proposition 5***
>
> In the product development network learning process, the cross-transformation positively contributes to speed-to-market for product development.

7.5 CONCLUSION

In exploring how firms learn about product development in their business networks, a multiple and exploratory case study is employed in this study. To ensure the reliability of the research, case study protocol and semi-structure interview protocol were used. In studying the research topic in successful product development projects, data were collected from three cases in different industries (e-business,

tourism, and oil). Case study samples were purposefully selected by a 'snow ball' approach involving a 'hub and spoke' structure. For construct validity, multiple sources of evidence (observation, interview, documentation, archival record, company collateral) were employed in three case studies. As a result, data were collected from 3 hub companies (where the successful product development project was initiated) with 36 spoke companies (that networked with a hub company). In doing data analysis, this study employed a process consisting within-case data analysis, cross-case patterns searching, and propositions shaping suggest by Eisenhardt (1989). NVivo 7 was used to help the coding and categorising large amounts of text. To ensure internal and external validity, within-case data were processed by employing plausibility tactics, clustering method suggested by Glaser and Strauss (1967) and Miles and Huberman (1994); pattern match, and replication logic together with literature enfolding were employed to search cross-case patterns (Eisenhardt 1989 and Yin 2003).

Results from the within-case data analysis suggest six major themes in product development network learning. The transfer of existing knowledge (TSF) is repeatedly found in initiating the inter-firm learning in product development business networks; followed by the cross-transformation of developed knowledge (CRT). The business networks provide companies opportunities to absorb (through the transfer) diversified knowledge. With the diversified knowledge, companies transform existing knowledge into new or advanced knowledge and return the advanced knowledge back into the business network partners. This continued and reiterative process is revealed among network partners in a current product development project as well as among previous, current, and future product development projects. . The cross-transformation of advanced knowledge is thus in effect. For the transfer and the cross-transformation of knowledge, four major themes (this study terms them DAPE) are suggested by the case study data. Companies engage dialogue (D) to stimulate network partners to think together. Companies engage articulation (A) to turn tacit knowledge into explicit in inter-firm learning in product development networks. Companies engage pollination (P) to 'integrate' diversified knowledge from different product development partners in the business networks. The

engagement of pollination can be horizontal (in the same NPD project) or vertical (in different NPD projects). Companies engage experience (E) to build a common knowledge base when learning with their product development network partners.

In sum, the results from the cross-case patterns searching suggest that companies learn about product development in their business networks by a process that consists of the transfer of existing knowledge and the cross-transformation of new/advanced knowledge. The results also reveal that in this process, companies engage dialogue, articulation and experience for the transfer of knowledge; and engage pollination, articulation and experience for the cross-transformation of knowledge. Six propositions are presented in this multiple-case study:

Proposition 1:

Companies learn about product development in their business networks by a process that consists of (1) the transfer of existing knowledge (access, collect); and (2) the cross-transformation of developed knowledge (develop, share); and the more the transfer is the more the cross-transformation will be.

Proposition 2

In the product development network learning process, companies apply dialogue, articulation and experience for the transfer of knowledge.

Proposition 3

In the product development network learning process, companies apply pollination, articulation and experience for the cross-transformation of knowledge.

Proposition 4

In the product development network learning process, the cross-transformation positively contributes to the uncertainty reduction for product development.

Proposition 5

In the product development network learning process, the cross-transformation positively contributes to speed-to-market for product development.

Figure 7.6 illustrates the research framework summaries the presented propositions:

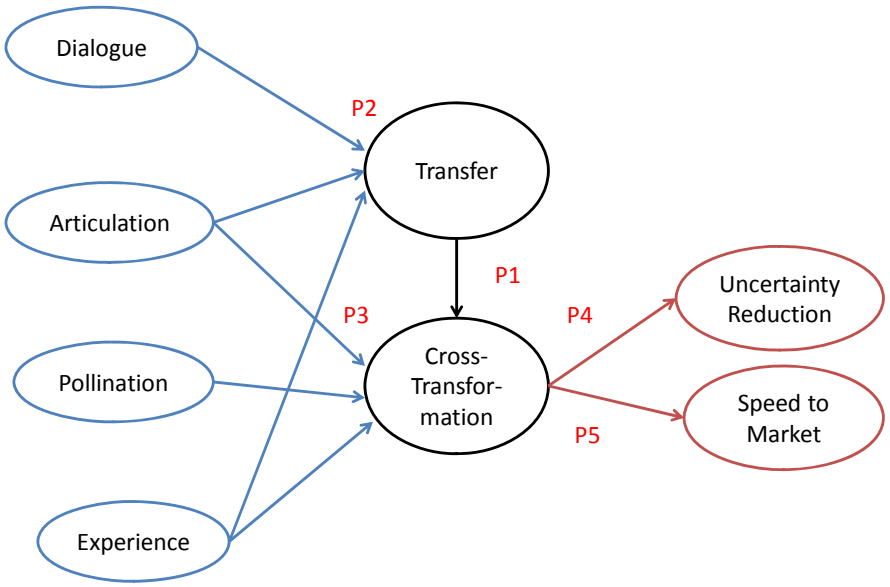


Figure 7.6: Research Framework (Source: Author)

CHAPTER 8

PRESENTATION
OF
SURVEY RESULTS

CHAPTER EIGHT

8.0 Introduction

8.1 Propositions and Hypotheses

Product Development Network Learning – Transfer
and Cross-Transformation
Antecedent Variables – DAPE
Dependent Variables – Uncertainty Reduction and Speed-to-Market
Mediating Effects

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Articulation and Experience
Constructs: Cross-Transformation, Dialogue and Pollination
Questionnaire

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Non-Response Bias

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Product or Service

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Importance of Network Partners

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Antecedent Variables – DAPE

Product Development Network Learning – Transfer and Cross-Transformation

Dependent Variables – Uncertainty Reduction and Speed-to-Market

8.7 Measurement Model Evaluation

- Confirmatory Factor Analysis

CFA Model Assessment

8.8 Structural Equation Model – Hypotheses Testing

Path Model

Mediating Effects

8.9 Conclusion

8.0 INTRODUCTION

This chapter aims to report and discuss the results of the survey research conducted in this study. The field survey research was carried out in assessing the substantive validity of the propositions that are captured and posited in case study. Before hypotheses testing, the researcher ensures that data are carefully examined; and the identified measurement and structural models are assessed and modified for goodness-of-fit. This chapter first specifies the propositions and their incorporated hypotheses. There are six propositions lead to twenty hypotheses for testing. Details will be discussed in section 8.1. After the propositions and hypotheses are specified, it then turns to discuss the proposed constructs and the derived survey instrument in section 8.2. The sampling and its procedures will be detailed in section 8.3. The collected data are then carefully examined. Section 8.4 reports the details on data examination in regard to missing data, outliners, normality, linearity and multicollinearity. It is followed by the discussion of the demographic profile of the sample in this survey research. Descriptive analysis on the proposed constructs is presented in section 8.5. A step before testing hypotheses is the measurement model evaluation. This step involves assessing measures by confirmatory factor analysis (CFA) and will be reported in section 8.6. Finally the structural equation model (SEM) for hypotheses testing will be detailed in section 8.7. All the survey analysis and results will be summarised and concluded in the final section 8.8.

8.1 PROPOSITIONS AND HYPOTHESES

In testing the propositions suggested from the case study, five groups of hypotheses are proposed. The first hypothesis is driven by the product development network learning process that contains the transfer and the cross-transformation of knowledge. The second and the third groups of hypotheses examine the antecedent variables that companies engaged for the transfer and the cross-transformation. The fourth and the fifth group of hypotheses focus on these dependent variables and intend to assess the impact of the proposed NPD network learning model on uncertainty reduction and on speed-to-market.

Finally, the sixth group of hypotheses examine two mediating effects: the mediating effects of the transfer between antecedent variables: Dialogue, Articulation, Pollination and Experience. and the cross-transformation and the mediating effects of the cross-transformation between the transfer and the dependent variables (uncertainty reduction and speed-to-market).

Product Development Networks Learning
– Transfer and Cross-Transformation

The study proposes a learning process in product development network that consists of (1) the transfer of existing knowledge and (2) the cross-transformation of developed/new knowledge. In order to conduct the 'transfer' of existing knowledge, firms need to have access and be able to collect product development knowledge from network partners. To be able to process the 'cross-transformation' of new/advanced knowledge, companies need to be capable to brought back different knowledge from network partners, develop advanced/new knowledge through joint product development activities; and share the newly developed knowledge among different network partners. Consequently, this thesis proposes the following:

> ***Proposition 1:***
> Companies learn about product development in their business networks by a process that consists of (1) the transfer of existing knowledge; and (2) the cross-transformation of developed knowledge; and the more the transfer is the more the cross-transformation will be.
>
> ***Hypothesis 1:*** The transfer positively leads to the cross-transformation of knowledge.

Antecedents Variables
– DAPE

Four major themes were suggested from the case study data, this study terms them DAPE (dialogue, articulation, pollination and experience). The case results indicate study found that companies applied dialogue, articulation and experience for the transfer of knowledge; and applied pollination, articulation and experience for the cross-transformation of knowledge. The second proposition and the second group of hypotheses thus are:

> ***Proposition 2***
> In the product development network learning process, companies apply dialogue, articulation and experience for the transfer of existing knowledge.
>
> ***Hypothesis 2a***: Dialogue positively impacts on Transfer.
> ***Hypothesis 2b***: Articulation positively impacts on Transfer.
> ***Hypothesis 2c***: Experience positively impacts on Transfer.

The third proposition and the related hypotheses are as follow:

> ***Proposition 3***
> In the product development network learning process, companies apply articulation, pollination and experience for the cross-transformation of developed knowledge.
>
> ***Hypothesis 3a***: Articulation positively impacts on Cross-transformation.
> ***Hypothesis 3b***: Pollination positively impacts on Cross-transformation.
> ***Hypothesis 3c***: Experience positively impacts on Cross-transformation.

Dependent Variables

– Uncertainty Reduction and Speed-to-Market

The case study results indicate that new product development reflects a progress into the uncertainty reduction and speed-to-market – by processing knowledge, and crating new/advanced knowledge. Data of the three case studies indicate that it is knowledge cross-transformation that leads to uncertainty reduction and speed-to-market. In order to assess the impact of the proposed network learning model on the uncertainty reduction and the speed-to-market, proposition four and proposition five are proposed. Based on the literature, four major sources of uncertainty are employed in this study: customer: refers to uncertainties about user needs; technological: uncertainties about the best technologies to employ; competitive: uncertainties about competitors; and resources: uncertainties about firm's effectiveness in allocating its human, financial and technical resources (Souder and Moenaert 1992; Lievens and Moenaert 2000; MacCormack and Verganti 2003). Proposition four/five and hypotheses are as below:

Proposition 4

In this process, Cross-transformation positively contributes to the uncertainty reduction for product development.

Hypothesis 4a: Cross-transformation positively impacts on Uncertainty Reduction in customer.

Hypothesis 4b: Cross-transformation positively impacts on Uncertainty Reduction in technology.

Hypothesis 4c: Cross-transformation positively impacts on Uncertainty Reduction in competition.

Hypothesis 4d: Cross-transformation positively impact on Uncertainty Reduction in resources.

Proposition 5

In this process, Cross-transformation positively contributes to speed-to-market for product development.

Hypothesis 5: Cross-transformation positively impacts on speed-to-market

Figure 8.1 summaries the proposed five groups of hypotheses:

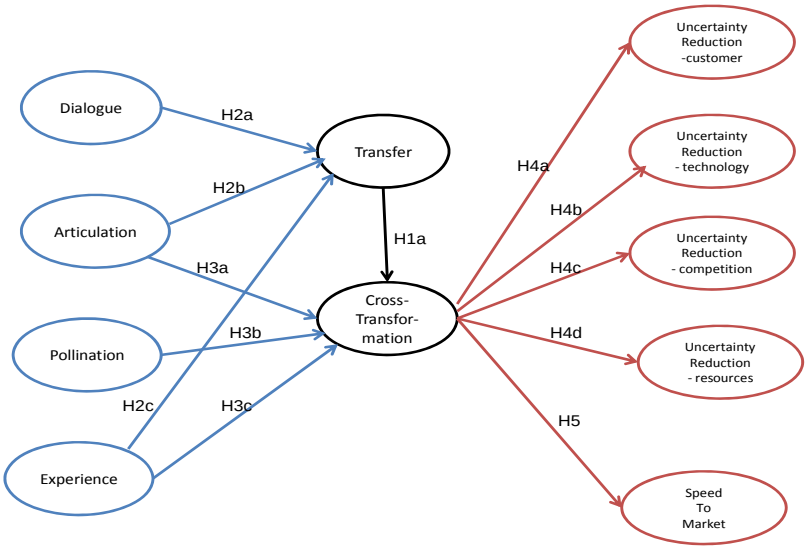

Figure 8.1: Research Framework (Source: Author)

8.2 CONSTRUCTS AND QUESTIONNAIRE

In testing the proposed hypotheses, eleven constructs were compiled. Items for constructs were first adopted from the literature if appropriate items were found. However, at the writing up of this thesis, product development network learning process is still an under-researched area. Some constructs were not available and were mainly drawn from this study's quantitative research findings. In summary, the following items were drawn from existing literature: Uncertainty Reduction (four constructs in customers, technology, competition and resources), Speed-to-Market, Transfer, Articulation and Experience. Items mainly drawn from the case study results together with the corresponded contention in the extant literature: Dialogue,

Pollination and Cross-Transformation. In total, eleven constructs are complied and the survey instrument (questionnaire) was prepared for the study.

Constructs:
Uncertainty Reduction, Speed-to-Market,
Transfer, Articulation and Experience

In studying the effectiveness of project team communication, Lievens and Moenaert (2000) used a series of scales to test the level of the uncertainty reduction that contains reduction in customer uncertainty, technological uncertainty, competitive uncertainty and the resources uncertainty. The Cronbach alpha values ranged from 0.74 to 0.91. This study adopted Lievens and Moenaert's uncertainty reduction's items. For the construct of the speed-to-market, this study borrowed the measuring items (Cronbach alpha: 0.88) from Akgun and Lynn's (2002) paper on new product development team improvisation and speed-to-market. Moorman (1995) items for the acquisition and transmission processes (alpha=0.70) were borrowed for the construct of the transfer. Items for the constructs of the articulation were drawn from Hakanson and Nobel (1998), Bresman et al. (1999), Zander (1991), Cummings and Teng (2003) and the findings of this study's quantitative data. The items asked respondents the extent of how feasible the knowledge can be learnt by talking, training, educating and trial and error Cronbach alpha value was 0.75 in Bresman et al. study. Items for the constructs of the experience were drawn from Simonin (1999) paper in studying knowledge transfer in strategic alliances. The Cronbach alpha was 0.93. Most constructs drawn from the journal papers showed acceptable to reliability estimates (0.70-0.93). An alpha level of 0.70 has been used as a cut-off value (Cronbach and Meehl 1967; Nunnally 1967).

Constructs:
Cross-Transformation, Dialogue and Pollination

Items of two antecedent constructs - dialogue and pollination and of the network learning process – cross-transformation are mainly compiled from this study's

quantitative data. Items for the construct of the dialogue asked the company the extent of listen to, speak to, think and interpreted together with network partners in developing products (Hart and Liu 2006, Isaacs 1993; Schein 1994; Hedlund 1994; Nonaka and Toyama 2005). Items of the construct of pollination asked respondents the extent of receiving and integrating different knowledge from different network partners in developing products (Hart and Liu 2006, Inkpen 1996; Beamish and Berdrow 2003). Finally the items of the construct for the cross-transformation asked companies the extent of bringing back, developing and sharing new/advanced knowledge from/to different product development network partners (Hart and Liu 2006).

Questionnaire

A structured on-line survey instrument (the questionnaire) involving closed-end questions was then prepared for large scale of survey research. SNAP 9 Professional was used to generate the web-online questionnaire. General instructions were given before the questions. Purposes of the general instructions were (1) to remind the survey is based on the company's practice on working with its important network partner(s) for a successful product development project(s) in the past 3 years; (2) to define successful product development projects(s); (3) to give instruction of how to complete and submit the questionnaire (4) to emphasise the confidentiality, to give contact details and to encourage to pass to the appropriate personnel. Before operationalising the constructs, the respondents were asked to rate the importance of their network partners in helping the successful product development projects (Question 1) and to rate the involvement of the important network partners (the ones rated 3 or more out of a 5 points scale) in various stages of new product development process (Question 2).

To operationalise the constructs, a Likert measurement scale of 1 to 7 was used (1 = Never; 4 = Sometimes; 7 = Always). Questions 3 to 10 covered all the items for the assessing constructs. In order to encourage the completion of the questionnaire, a reminder of 'almost done' was appeared when respondents completed question 4.

Question 11 to 15 collected the data of samples' demographic profile. Companies contact details were collected on the last page for sending a summary of final report.

The content validity of a questionnaire is typically established through the literature review and expert judges (Cook and Campbell 1979). For the content validity, this study built up the questionnaire mainly based on the related literature review and case study results. Moreover, in searching the expert judgements, prior to data collection, a pre-test of the survey instrument (the questionnaire) was organised in five key companies from quantitative research. The purpose of this pre-test was (a) to assess construct validity and further purify the scales if necessary and (b) to evaluate and improve the quality of the questionnaire prior to full implementation of the survey. Overall, the questionnaire was clear and easy to complete, except some wordings that were revised as suggested. The questionnaire can be found in the appendix.

8.3 SAMPLE AND PROCEDURES

This section first details the sampling frame, sampling techniques and sample size; it then is followed by the discussion of the non-response bias in this study.

Sampling

Primary data were collected using a web survey administered to companies that work with network partner(s) and have successful product development projects in the past three years. A successful product development project is defined as one that has been brought from idea to commercial success (Griffin and Page 1996; Craig and Hart 1992; Hart et al. 1999). The sampling frame of this study was based on the Scottish-Enterprise directory in eleven industries: food and beverages, finance and insurance, petroleum and fuel, chemicals and pharmaceuticals, rubber and plastic, hotel/tourism/leisure, machinery and equipment, hi-tech and e-business, telecommunications, building and construction, consultancy/research/training. 3,650 prospective companies were randomly selected from the sampling pool. For the

appropriate sample size, the literature has suggested that incorporate with Structure Equation Modelling (SEM), a minimum ratio of at least five respondents for each estimated parameter (or item) is recommended (Hair et al. 1998). Totally, 36 items were covered in 11 constructs; at least 180 usable samples were required. Another recommendation for sampling is always to test a SEM model with a sample is of 200, because the sample size of 200 is proposed as being the 'critical sample size' (Hoelter 1983). Therefore, the goal of this sampling is to obtain more than 200 usable respondents.

A cover letter with the web-site for the questionnaire was emailed out to all prospective companies. The purpose of this letter was (1) to explain the purpose of the research; (2) to highlight the easiness of completing the questionnaire; (3) to stress the confidentiality of this study; (4) to remind a result report as a token of appreciation; and (5) to leave contact details for any questions. General instructions were also provided before the survey questions. Companies were advised that the survey was based on the company's practice on working with its important network partner(s) for a successful product development project(s) in the past 3 years. And the definition of a successful product development project was provided in the general instructions.

Over a period of several months, the cover letter with the website for questionnaire was emailed to the sample of 3,650 companies in three waves. Each wave followed the same procedure that three weeks of following the first email, non-respondents were telephoned, reminded of the questionnaire, and encouraged to complete and return it, followed by a second email with the website for questionnaire. As a result, in the first wave, 1,500 emails were sent out to 1,500 companies during 15 May – 5 June 2008. 62 completed questionnaires were received (4.1% response rate). Non-respondents were telephoned and 2nd emails were sent out during 9-30 June 2008. 26 completed questionnaires were received (12.3% response rate). In the second wave, 1,500 emails were sent out during 1st – 20th July 2008. 68 completed questionnaires were received (4.6%). Non-respondents were then telephoned and 2nd emails were sent out during 21 July – 8 August 2008. 22 completed questionnaires were received

(11.1%). In the third wave, 650 emails were sent out during 20 February – 15 March, 2009. 33 completed questionnaires were received (5.1%). 5 completed questionnaires were received (11.6%) after phone calls and 2nd emails.

Of the total emails, 305 emails were failed due to wrong address and 129 rejected emails were received. (94% due to irrelevance; 3% company policy did not allow to do any survey; 2% key informant was not available; 1% did not specify reason). After eliminating and companies with wrong address and companies who indicated that the questionnaire was inappropriate for their organisation or experience, the overall sample was reduced from 3650 to 3,216. In total, 217 completed web questionnaires were sent back. The respond rate was 6.7%. Among 217 return questionnaires, 6 were found un-usable. Thus, 211 (6.6%) usable samples were obtained.

Non-Response Bias

To test non-response bias, Extrapolation method was uses (Armstrong and Overton 1977). Extrapolation methods are based on the assumption that subjects who respond less readily are more like non-respondents (Pace 1939). "Less readily" has been defined as answering later, or as requiring more prodding to answer. This study adopted one of the most common types of extrapolation which is carried over successive phase of a survey. "Phase' refers to the response generated by a stimulus; in this study it is a follow up phone calls. Companies that responded in later phases are assumed to have responded because of the increased stimulus and are expected to be similar to non-respondents. This study had three waves, each waves contains the phases of 'before' and 'after' the 2nd phase calls and emails. One-way analysis of variance (ANOVA) tests was used to check if there were significant differences between the groups before and after the second email in (a) company size; (b) company primarily provides products/services/mix; and (c) the market (consumer/b2b/mix) the company is. ANOVA tests showed no significant differences (at p=0.05) between groups of before and after stimulus in the above three variables, which suggests that non-response bias was not a serious concern

(Armstrong and Overton 1977). The researcher hence decided that no modification was needed. The testing results are shown below:

Variables	F	Sig	Suggests
Size of Company	1.67	0.17	No significant difference
Product or Service	1.54	0.23	No significant difference
B2C or B2B	2.82	0.07	No significant difference

8.4 DATA EXAMINATION

Careful examination of data leads to better prediction and more accurate assessment of dimensionality. This section describes the methods used in this study to assess missing data, outliners, normality, homoscedasticity, linearity and multicollinearity, followed by the assessment results and the decision for any modifications on the dataset.

Missing Data

A missing data process is any event external to the respondent (such as data entry errors or data collection problems) or action on the part of the respondent (such as refusal to answer) that leads to missing values (Hair et al. 1998, p46). Missing data is one of the most pervasive problems in data collection. The challenge of the researcher is to address issues raised by missing data that affect the generalisability of the results. If missing values are scattered randomly through a data matrix, they rarely pose severe problems. However, non-randomly missing values are issues; no matter how few of them, that impact the generalisability of results (Tabachinick and Fidell 2001). Moreover, it is commonly accepted that if the number of missing data is relatively small within a large database, the problem could be considered as less serious and any treatment should yield similar results (Kline 2005).

In this survey, the number of the missing data was ranged from 2 to 9 in the questioned items. The missing values were scattered randomly through a data matrix. Moreover, it remained at least 202 useable values for each items. The number of useable data (202) is higher than the minimum sample size threshold (188) in this study. To diagnosing the randomness of the missing data, the researcher adopted the process suggested by Hair et al. (1998) of testing a few variables (market size, product/service provided, market) by forming two groups – observation with missing data and those with valid values. One-way analysis of variance (ANOVA) tests was used to check if there were significant differences between these two groups in (a) company size; (b) company primarily provides products/services/mix; and (c) the market (consumer/b2b/mix) the company is. ANOVA tests showed no significant differences (at p=0.05 level) between these two groups in the above three variables. The results are shown as below that missing data are randomly scattered with no distinct pattern; that is, missing at random (MAR). Thus, any remedy to treat this missing data is acceptable (Hair et al. 1998).

Variables	F	Sig	Suggests
Size of Company	0.38	0.82	No significant difference
Product or Service	0.66	0.52	No significant difference
B2C or B2B	0.28	0.76	No significant difference

To deal with missing data, several approaches are suggested. Incorporated into Structural Equation Modelling (SEM), there are two ways in dealing with missing data. The first is the direct method, in which model parameters are estimated with both the complete and incomplete data (Allison 1987; Joreskog and Sorbom 1993). This approach is rarely used, however, given the complexity of the resulting model. More common is an indirect method, whereby an input data matrix is estimated using some or all of the available information. Recent research has shown that the EM method introduces the least bias into the estimated models (Brown 1994). The EM approach in SPSS is an iterative two-stage method (the E and M stages) in which the

E-stage makes the best possible estimates of the missing data and the M-stage then makes estimates of the parameters (means, standard deviations, or correlations) assuming the missing data were replaced. The process continues going through the two stages until the change in the estimated values is negligible and they replace the missing data. This study adopted the EM approach. Through SPSS 17 Professional, missing data were replaced via EM approach.

Outliers

Outliers are cases with extreme values on one variable or a combination of variables that unduly influence statistics (Tabachnick and Fidell 2001). Problematic outliers are not representative of the population and are counter to the objectives of the analysis. Problematic outliers can seriously distort statistical tests (Hair 1998). It is suggested that problematic outliers can be an issue when skewness level above 2 and kurtosis level above 5 (Ghiselli, Campbell and Zedeck 1981). A frequency analysis and Mahalanobis distance detect kurtosis and skewness. Moreover, outliers can be identified from a univariate, or multivariate perspective (Hair 1998). A univariate outlier is a case with an extreme value on one variable. The univariate perspective for identifying outliers examines the distribution of observations and selects as outliers those cases falling at the outer ranges of the distribution. For larger samples (> 80 observations), the guidelines suggest that the threshold value of standard scores range from 3 to 4. A widely accepted rule of thumb is that a value more than 3 standard deviations away from the mean is considered as outlier (Kline 2005). Furthermore, outliers can also be identified by involving a multivariate assessment of each observation across a set of variables. The multivariate outlier can be diagnosed with the "Mahalanobis D^2 measure", which is a measure to assess the position of each observation comparing with the centre of all observations on a set of variables (Hair et al. 1998). It is suggested that a very conservative level 0.001 be used as the threshold value for designation as an outlier (Hair et al. 1998; Tabachnich and Fidell 2001).

In examining the data, a frequency statistics showed Skewness ranged from -1.258 – 0.776 and kurtosis ranged from -1.181 – 1.258. The results suggest that outlier should not be a serious concern that the variables are well below the level skewness of 2 and kurtosis of 5. The researcher further assessed the descriptive statistics by running explore results to check the univariate outlier. The vertical boxplot showed that case 78 was identified with extreme low value on question 9a (value 1 vs. the mean value 5.41). In order to examine whether this extreme case has any significant impact on the findings, it was tested by two groups of CFA models. The result showed the removal of this case was found to have no significant effect on the path coefficients and fit indices. The change in Chi-square for two CFA models (n=211, CMIN/DF=1.520; n=210, CMIN/DF=1.540) was not significant at p=0.05 level (Δx^2=3.59). Consequently, this case was retained in the dataset for further analysis.

To check the multivariate outliers, the Mahalanobis D^2 was measured. The results showed that there were nine cases (case 145, 182, 126, 63, 88, 155, 106, 78, 87) detected with Mahalanobis D^2 at the p<0.001. The researcher further inspected the deviant cases to decide whether to retain or discard those cases. It was noticed that those outliers were not rooted from errors of participant responses or data recording. In addition, the Chi-square difference for two CFA models (n=211, CMIN/DF=1.520; n=202, CMIN/DF=1.559) was not significant at p=0.05 level (Δx^2=6.96). No observations seem to demonstrate these multivariate outliers should be eliminated. No observations were extreme on a sufficient number of variables to be considered unrepresentative of the population. It is suggested that outliners should be retained unless they are proved not representative of the entire population (Hair et al. 1998). Therefore, it was decided to retain all the cases.

Normality

The most fundamental assumption in multivariate analysis is normality. It refers to the shape of the data distribution for an individual metric variable and its correspondence to the normal distribution, the benchmark for statistical methods (Hair et al. 1998). Multivariate normality (the combination of two or more

variables) means that the individual variables are normal in a univariate sense and that their combinations are also normal. Thus, if a variable is multivariate normal, it is also univariate normal (Hair et al. 1998). The simplest diagnostic test for normality is a visual check of the histogram that compares the observed data values with a distribution approximating the normal distribution. A more reliable approach is the normal probability plot which compares the cumulative distribution of actual data values with the cumulative distribution of a normal distribution. One characteristic of the distribution's shape, the kurtosis, is reflected in the normal probability. Kurtosis refers to the 'peakedness' or 'flatness' of the distribution compared with the normal distribution. In addition to examining the normal probability plot, one can also use statistical tests to assess normality. A simple test is a rule of thumb based on the skewness and kurtosis values. The statistic value (z) for the skewness value is calculated as: z(skewness) = skewness / $\sqrt{6/N}$ (where N is the sample size), or z(kurtosis) = Kurtosis / $\sqrt{24/N}$. If the value exceeds a critical value (± 2.58) indicates we can reject the assumption about the normality of the distribution at the .01 probability level or a critical value (± 1.96) at .05 probability level.

To check normality in this study, the researcher checked the statistic value (z) and found that all the (z) values were less than the critical value (± 2.58) except variable q3b (z = 3.558). To modify variables, data transformation is suggested (Hair et al 1998). For non-normal distributions, the two most common patterns are 'flat' distributions and skewed distributions. Hair et al (1998) suggested that for the flat distribution, the most common transformation is the inverse (e.g. 1/Y or 1/X); and for skewed distributions can be transformed by taking the square root, logarithms (p.77). Usually negatively skewed distributions are best transformed by employing a square root transformation, whereas the logarithm typically works best on positive skewness. The non-normality issue found in q3b was a positive skewness. Data was transformed by employing logarithm transformation. After the transformation, q3b's z value = -1.874, a well below the critical value (± 2.58). No major concern on the data normality was indicated.

Linearity and Multicollinearity

An implicit assumption of all multivariate techniques based on correlational measures of association is linearity (Hair et al. 1998). In the case of individual variables, this relates to the patterns of association between each pair of variables and the ability of the correlation coefficient to adequately represent the relationship. Researchers rely on the visual inspection of the relationships to determine whether nonlinear relationships are present (Hair et al. 1998, p83). In examining data linearity in this study, the residual scatterplots were checked, which are generated from the multiple regression procedure. Due to the space limits, these results are not presented. The residual assessment for the mis-specification will be further discussed in section 8.6 measurement model evaluation.

Prior to conducting the structural model, multicollinearity also needs to be assessed. The multicollinearity exists when the independent variables are highly correlated (r = .90 or above). The interpretation of path coefficients may be problematic due to multicollinearity among variables. This was assessed by observing correlations among variables in the measurement model output from AMOS 17.0. The results are shown on table 8.1: 'descriptive statistics and correlations for constructs'. None of the correlations among variables in this study were higher than .80. Consequently, Multicollinearity is not an issue.

8.5 DEMOGRAPHIC PROFILE OF THE SAMPLE

In the field survey, demographic profiles of the samples were collected in their industry category, company size, product or service and B2C or B2B. This section reports the details.

Industry Category

The survey samples were from a diversified pool. 25% of the respondents were from hi-tech and e-business industry. Each of the following industries had at least 10% of

respondents from the total samples: Industries of chemicals/pharmaceuticals, food/beverages, consultancy/research/ training and machinery/equipment. Respondents from hotel/tourism/leisure and rubber/plastic had less than 5% samples. Details are shown as below. Figure 8.2 illustrates the results:

Industry	Percentage
Hi-Tech & e-Business	25%
Chemicals & Pharmaceuticals	15%
Food & Beverages	12%
Consultancy/Research/Training	11%
Machinery & Equipment	10%
Telecommunications	7%
Finance & Insurance	7%
Petroleum & Fuel	5%
Building and Construction	5%
Hotel / Tourism / Leisure	2%
Rubber & Plastic	1%

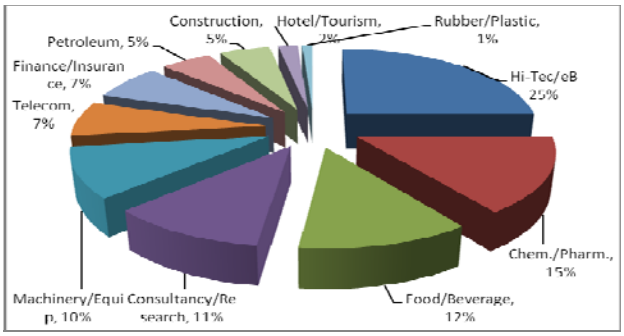

Figure 8.2: Industry Category (Source: Author)

Company Size

A big portion of respondents in this study were from small companies. More than half (57%) of the respondents were from companies had less than 50 people, and one fourth of the respondents were from companies with size of more than 200 Staff. Details are shown as below. Figure 8.3 illustrates the results:

Company Size	Percentage
Less than 10 Staff	30%
10 – 49 Staff	27%
50 – 199 Staff	18%
200 – 499 Staff	9%
500 or more Staff	16%

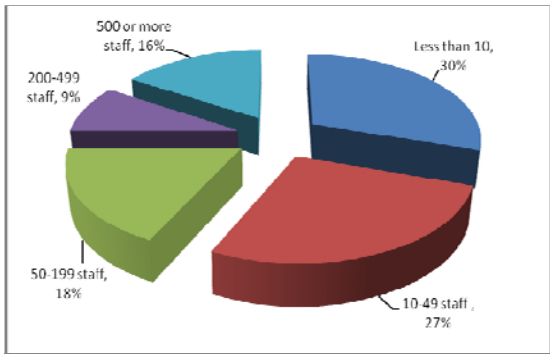

Figure 8.3: Company Size (Source: Author)

Product or Service

In the survey, respondents were asked to indicate whether the company primarily provided products (physical goods) or services or mix of products/services. A rather even allocation was found. The results showed 37% of the sample companies provided products (physical goods), 29% were services and 34% were mix. Figure 8.4 illustrates the results:

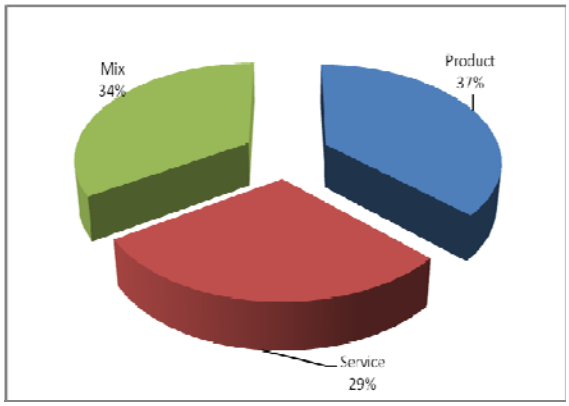

Figure 8.4: Product or Service (Source: Author)

B2C or B2B

Furthermore, respondents were also asked to indicate if the company‘s products/services are primarily sold in consumer market or business-to-business (b2b) market or mix of both. As expected, the majority of the companies were from the b2b sectors. The results showed 12% of the sample companies were in consumer market, 74% were in b2b and 14% were mix. Figure 8.5 illustrates the results:

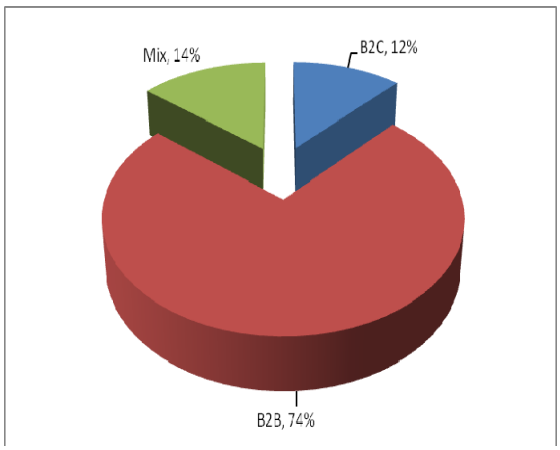

Figure 8.5: B2B or B2C(Source: Author)

Respondents Role

Finally, respondents were asked to indicate their role in the company. A high percentage (51%) of the respondents were the owner/CEO. Since a high percentage of the samples were from small companies (less than 50 staff), it may not be a surprise for the high percentage of the respondents were the owner/CEO; it followed by the role of marketing/sales and new product development. Details are shown as below. Figure 8.6 illustrates the results:

Informant's Role	Percentage
Owner/Chief Executive	51%
Marketing/Sales	16%
New Product Development	15%
IT/Technical/R&D	10%
Operations/Manufacturing	5%
Finance	3%

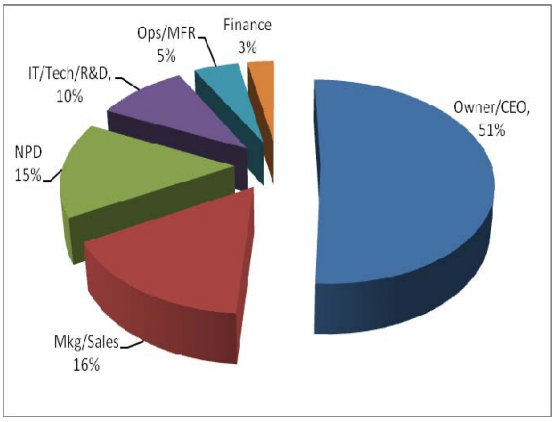

Figure 8.6: Respondents Role (Source: Author)

8.6 DESCRIPTIVE ANALYSIS

This section reports the descriptive analysis results on the following areas: the important level of the business network partners, company's network involvement in product development process, the four antecedent constructs (DAPE), the transfer, the cross-transformation and the dependent constructs (uncertainty reduction and speed-to-market). The mean values and standard deviation results will be reports for all, and reliability results by assessing Cronbach's Alpha values will be presented.

Importance of Network Partners

This study investigates learning with business network partners. It is of importance to understand which business network partners the respondents referred to and how important they were to the successful product development projects. For this reason, respondents were asked to rate the extent of importance of their network partners in helping the successful product development projects (1 = not at all important, 5 = extremely important). The findings showed that 'customers', as the product development network partners, had the highest mean value (4.02), followed by suppliers (3.60). Interesting enough, competitor (2.62) has been placed as the fourth network partners and the mean value was not very different from joint venture (2.71) that companies viewed as important business network partners for the successful project development projects. Details are shown as below. Figure 8.7 illustrates the results::

Network Partners	Mean	Std. Deviation
supplier	3.60	1.21
competitor	2.62	1.13
joint venture	2.71	1.34
customer	4.02	1.20
distributor	2.54	1.31
trade association	2.02	0.99
academics	2.11	1.05

consultant	2.46	1.20

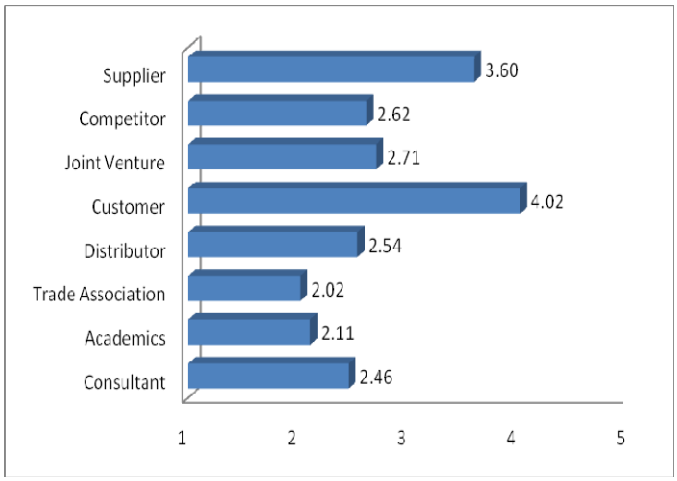

Figure 8.7: Importance of Network Partners (Source: Author)

Network Partners Involvement in NPD Process

In the field survey, the respondents were also asked to rate the extent (1=Never, 4=sometimes, 7=always), of involvement of those network partners who they rated 3 or more in the previous question. The extent of the involvement of network partners was found all above the average (mean values: 3.96-5.10) at each stage of the new product development process. The results showed that the process of analysing customer requirements and needs had the highest mean value (5.10) followed by developing new product according to market needs (5.07), generating new product ideas (4.72), finding commercial applications of new product ideas or technologies (4.61) and launching activities (4.60). The findings also showed that respondents rated the process of finding competitors move in product development process the lowest (3.96). Details are shown as below. Figure 8.8 illustrates the results:

Network Involvement in NPD Process	Mean	Std. Deviation
Setting NP goals and Priorities	4.58	1.74
Generating NP ideas	4.72	1.51
Finding commercial applications of NP ideas	4.61	1.63
Analysing customer requirements and needs	5.10	1.67
screening ideas	4.43	1.51
Finding competitors moves	3.96	1.57
Developing NP according to market needs	5.07	1.53
Test-marketing	4.33	1.74

Launching activities	4.60	1.77

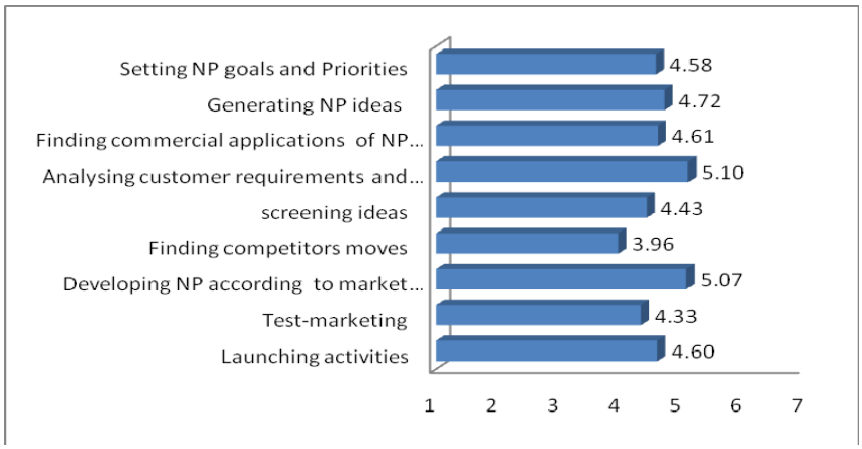

Figure 8.8: Network Partners Involvement in NPD Process (Source: Author)

Antecedent Variables

– DAPE

Items for the construct of ***Dialogue*** were mainly compiled from the qualitative data and referenced from the literature. Items reliability was tested by SPSS 17 and judged the set reliable. The item reliability was assessed by the Cronbach's Alpha value 0.88, was well above the threshold 0.70. The survey results revealed that in developing new products, dialogue was employed to a great extent (mean values 4.99-5.73). The highest mean value (5.73 in a 7 point scale) was found in the item – the company spoke to the important network partners. The comparative low mean value was 4.99 in 'company interpreted the product development knowledge with the important network partners'. The results are reported in the following tables:

Descriptive Statistics

Dialogue	N	Mean	Std. Deviation
3a...listened to the above important network partners.	211	5.65	1.179
3b...spoke to the above important network partners.	211	5.73	1.122
3c...thought together with the above important network partners.	211	5.00	1.363

3d...interpreted the product development knowledge with the above important network partners.	211	4.99	1.438
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.882	4

In terms of engaging ***Articulation*** in working with partners in product development networks, the results showed the Cronbach' Alpha is 0.73, slightly lower than the value (0.75) from Bresman et al (1999) study. The mean values were ranged from 4.08 to 5.36. The highest mean value was on the item that companies understood network partners knowledge by talking to their experienced personnel is the highest (5.36 in 7 points scale). The item that companies understood knowledge by studying blueprints, documents or plans has been indicated as comparative the lowest (4.08). The results for each item are reported as below:

Descriptive Statistics

Articulation	N	Mean	Std. Deviation
4a...understood knowledge from network partners by studying a complete set of blueprints, documents or plans.	211	4.08	1.773
4b...understood knowledge from our network partners by talking to their experienced personnel.	211	5.36	1.348
4c...spent time in trial and error (experimenting) and developed a sense of the feasibility of knowledge from network partners.	211	4.84	1.519

4d. It was a doable job to educate and train our company's PD personnel with knowledge from our network partners.	211	4.39	1.524
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.725	4

For the construct ***Pollination,*** items were proposed by this study. The item reliability was examined by the Cronbach's Alpha value, 0.82, well above the acceptable threshold (0.70). The mean values of the items were found high at the level of 4.6. This confirms the findings from the quantitative data that companies apply pollination in working with business partners in product development networks. This construct was mainly the finding from the qualitative research in this study. The survey results are reported as below:

Descriptive Statistics

Pollination	N	Mean	Std. Deviation
5a...continuously received different knowledge in product development projects.	211	4.55	1.356
5b...continuously integrated different knowledge in product development projects.	211	4.56	1.271
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.815	2

For the construct ***Experience,*** The Cronbach's Alpha value was 0.86 which is lower than the one in Simonin (1999) paper (his alpha value is 0.93). The survey results also confirmed that companies applied experience to a great extent when working

with business partners in product development networks. The mean values ranged from 4.75 to 5.02. The following table illustrates the findings:

Descriptive Statistics

Experience	N	Mean	Std. Deviation
6a...had a high level of expertise with our partners technology/process know-how.	211	5.02	1.309
6b...had a high level of experience with our partners technology/process know-how.	211	4.75	1.368
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.864	2

Product Development Networks Learning – Transfer and Cross-Transformation

To understand how companies practice the proposed learning process in product development networks, this study proposed two constructs (the transfer and the cross-transformation). Items for the transfer were borrowed from the ones in Moorman (1995) work and items for the cross-transformation were mainly based on the qualitative findings in this study.

For the ***Transfer,*** items Cronbach's Alpha value, 0.80, was well acceptable. This value is above the alpha value (0.70) from the work in Moorman (1995). The survey results indicated the mean values were at the range of 4.80 – 4.97. The item 'company shared knowledge with network partners had the highest mean value (4.97). The following table shows the results:

Descriptive Statistics

Transfer	N	Mean	Std. Deviation

8a...had access to network partners knowledge.	211	4.86	1.099
8b...collected network partners knowledge.	211	4.80	1.276
8c...shared knowledge with network partners.	211	4.97	1.240
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.800	3

As to the construct of the ***Cross-Transformation,*** the items Cronbach's Alpha value (0.80) was well acceptable. The mean values were all high, ranged from 4.45 – 4.69, with 'worked on the collected knowledge to reduce its complexity' (4.69) as the highest mean value. Details are reported as below:

Descriptive Statistics

Cross-Transformation	N	Mean	Std. Deviation
8d...worked on the collected knowledge to reduce its complexity.	211	4.69	1.335
8e...developed advanced/new knowledge through joint activity.	211	4.62	1.359
8f...brought back new knowledge from different important network partners in joint activity.	211	4.61	1.320
8g...shared our newly gained knowledge to all network partners when it is needed.	211	4.45	1.480
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items

Reliability Statistics

Cronbach's Alpha	N of Items
.798	4

Dependent Variables

- Uncertainty Reduction and Speed-to-Market

To understand how learning with network partners impacts on uncertainty reduction in developing products, this study adopted Lievens and Moenaert (2000) ***Uncertainty Reduction*** items. Respondents were asked to answer the extent of the uncertainty reduction in customer, technology, competition and resources. Results of the Cronbach's alpha value tests were slightly different from those in Lievens and Moenaert (2000) findings:

(Cronbach's Alpha Value comparison)

	This study	Lievens&Moenaert (2000)
Uncertainty reduction in customer	.85	.74
Uncertainty reduction in technology	.84	.91
Uncertainty reduction in competition	.83	.85
Uncertainty reduction in resources	.86	.80

The survey results also showed that the mean values of uncertainty reduction in customer were found higher (4.66 – 5.41), and those in competition were found comparative lower (3.80 – 3.94). The following tables detail the results in descriptive statistics:

Descriptive Statistics

Uncertainty Reduction -Customer	N	Mean	Std. Deviation
9a...the customer needs (user requirements).	211	5.41	1.314
9b...the potential market.	211	5.06	1.322
9c...the buyer behaviour of the potential customer.	211	4.66	1.520
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.853	3

Descriptive Statistics

Uncertainty Reduction -Technology	N	Mean	Std. Deviation
9d...the quality of the applied technologies (e.g. information technologies).	211	4.61	1.345
9e...the user-friendliness of technologies.	211	4.59	1.269
9f...the cost-efficiency of the technologies.	211	4.62	1.411
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.842	3

Descriptive Statistics

Uncertainty Reduction -Competition	N	Mean	Std. Deviation
9g...the technological strategy of the competition.	211	3.94	1.567
9h...the marketing strategy of the competition.	211	3.80	1.596
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.827	2

Descriptive Statistics

Uncertainty Reduction -Resources	N	Mean	Std. Deviation

9i...the required R&D strategy for the product development projects.	211	4.67	1.375
9j...the required technological support for the product development projects.	211	4.74	1.382
9k...the required personnel for the product development projects.	211	4.67	1.441
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.857	3

Finally, to understand the impacts of learning with business network partners on ***Speed-to-Market***, respondents were asked to answer the extent to four items which were adopted by from Akgun and Lynn's (2002) items for speed-to-market . The findings showed Cronbach's Alpha's value = .88 in this study. This value is consistent with the Alpha value (.88) from Akgun and Lynn's (2002) paper. Mean values for this construct were ranged from 3.96 to 4.65. The following tables illustrate the results:

Descriptive Statistics

Speed-to-Market	N	Mean	Std. Deviation
10a...developed and launched faster than the major competitors for a similar product.	211	4.65	1.459
10b...completed in less time than what was considered normal and customary for our industry.	211	4.48	1.521

10c...launched on or ahead of the original schedule developed at initial project go-ahead.	211	3.96	1.466
10d. My company's top management was pleased with the time it took us from product idea to full commercialisation.	211	4.42	1.573
Valid N (listwise)	211		

Reliability Statistics

Cronbach's Alpha	N of Items
.878	4

8.7 MEASUREMENT MODEL EVALUATION - CONFIRMATORY FACTOR ANALYSIS

This section focuses on presenting the first part of Structure Equation Modelling (SEM) analysis: the measurement model. This step involves assessing measures by Confirmatory Factor Analysis (CFA). CFA is appropriately used when the researcher has some knowledge of the underlying latent variable structure (Byrne 2001), which was the case in this study. CFA plays an important role in structural equation modelling, since SEM is a confirmatory method. CFA models are used to assess the role of measurement error in the model, to validate a muti-factorial model, to determine group effects on the factors (Hair et al., 1998). The CFA model also provides powerful evaluation on construct validity, unidimensionality and valuable diagnostic information (Bagozzi et al. 1991). The focal constructs were entered into the CFA procedure with three steps.

First, to assess the measurement models, a wide range of goodness of fit indices was applied based on the recommended overall fit index by Arbuckle (2003) and Kline (2005). That is, the acceptable fit is adopted with the following thresholds: Chi-

Square (X^2) at $p<0.05$ level, X^2/df value < 3; GFI (Goodness-of-Fit Index) > 0.90; CFI (Comparative Fit Index) > 0.90; TLI (Tucker-Lewis Index) > 0.90; RMSEA (Root Mean Square Error of Approximation) < 0.08. The main purpose of this procedure is to assess a model's overall fit to determine the degree to which the model as a whole is consistent with the data generated from this study.

Second, after the constructs measurement model was accessed, it was further examined by the unidimensionality, reliability, convergent validity and discrimant validity. The assessment of unidimensionality is to perform CFA of a multiple-indicator measurement model via goodness-of-fit indices along with misfit diagnostic tools such as standardised residuals and modification indices (Anderson and Gerbing, 1988). In this study, misfit in the model was detected by assessing Residuals and Modification Indexes (MIs). Both the matrix of unstandardised residuals and that of standardised residuals are presented in the optional AMOS (Statistics 17) output. Standardised Residuals > ±2.58 are considered statistically significant at a 0.05 level which signifies substantial prediction error for a pair of indicators (Joreskog and Sorbom 1993, Bryne 2001). Modification indexes (MIs) capture the misspecification that reflects the extent to which the hypothesised model is appropriately described (Joreskog and Sorbom, 1993). If a MI value is larger than 3.84, it suggests that a statistically significant reduction in the chi-square could be obtained when the revised model is estimated (Hair et al., 1998). In this sense, high MIs suggest that the tested items have a strong degree of common variance, in which the modification is needed.

Finally, the constructs of interests in this study are reported via 'multi-item' scales. To generate findings from these measurements, a central part in the development of any scale is establishing its reliability and validity (Boudreau et al. 2001). Reliability concerns the degree to which a set of latent construct indicators are consistent in their measurements, that is, 'do the items in the scales get well together?' Composite Reliability (CR) and Average Variance Extracted (AVE) measures were adopted to assess the internal consistency reliability. For composite reliabilities, values greater than 0.6 are desirable (Bagozzi and Yi 1988). AVE values greater than 0.5 are

considered adequate (Bagozzi and Yi 1988). Validity concerns the extent to which a set of measure correctly represents the concept of study (Hair et al. 1998). To assess validity, Discriminant Validity measures were adopted. That is, if within each possible pairs of constructs the shared variance observed is lower than the minimum of their AVEs, then discriminant validity is evidenced (Fornell and Larcker 1981).

Through the process for misfit, some items were found too similar and could be considered as redundant. This study adopted the suggestion that redundant items can be removed (Hair et al. 1998). Theoretical justifications were also checked before modification. Model fit, constructs reliability and validity were then assessed after the modification. The following reports the details.

CFA Model Assessment

In a regression analysis with a set of independent variables explaining variance in the dependent variables, it is desirable to establish that the independent variables do not have too much shared variance (otherwise an issue of multicollinearity). But it is also expected some or all the independent variables to have a strong correlation (or shared variance) with the dependent variables. Therefore, before the overall model assessment, independent and dependent variables were assessed respectively. Essentially, the model involves a three layered structure with independent constructs DAPE (dialogue, articulation, pollination and experience) as the first layer, transfer and cross-transformation as the second layer, and dependent constructs (uncertainty reduction and speed-to-market) as the third layer. In order to manifest clearly the model fit, reliability and validity, the model assessment was conducted by three separate CFA analyses. Some misfits were detected. Modification was made and the final trimmed model was obtained. The new model after modification was then assessed for the model fit, reliability and validity.

The First Layer: DAPE

Before reporting the results of the CFA model assessment, the model is dissected and the component parts are listed as follows:

1. There are four constructs, as indicated by the four ellipses labelled Dia (Dialogue), Art (Articulation), Pol (Pollination), Exp (Experience),
2. Four factors are intercorrelated, as indicated by the two-headed arrows.
3. There are twelve observed variables, as indicated by the 12 rectangles.
4. The observed variables load on the factors in the following patterns 3a-3d load on Factor Dia, 4a-4d load on Factor Art, 5a-5b load on Factor Pol and 6a-6b load on Factor Exp. Each observed variables loads on one and only one factor.
5. Errors of measurement associated with each observed variable are uncorrelated.

The results of the CFA showed that the model fit was not acceptable ((X^2/df=4.40; GFI = .86; CFI=.96; TLI=.87; RMSEA=.13). The chi-square: degree of freedom ratio, higher than the cut off point 3, was not acceptable. The incremental fit measures, CFI (.96) was acceptable, but, TLI (.87) was lower than the traditional cut-off value of 0.90. The RMSEA (.13) did not lower than the adequate fit cut-off 0.080 (Malhotra and Birks 2007). Misfit in the model was detected by assessing residuals (> ±2.58) at a 0.05 level and modification indexes (> 3.84). Items 3c and 3d were first found high MI values. After the theoretical justifications were checked, the researcher decided that items 3c and 3d may not be appropriate to represent 'dialogue' where to listen and to speak are the essential elements. Items 3c and 3d were then removed from the variable Dialogue. Moreover, items 4a and 4b were also found high MI values. The researcher found that item 4c and 4d may well cover the activities in items 4a and 4b, and decided to remove items 4a and 4b from the variable Articulation. There were no misfit issues detected in items for variable Pollination and variable Experience, and all the items were kept.

After the modification, CFA model was run to test the model fit again. The results of the CFA model after modification showed that all factor loadings (standardised regression loadings) were higher than 0.60 and all critical ratios (t-values) are significant at p=0.001 level. The model fit indices suggest the proposed measurement model achieved a good fit (X^2/df=1.52; GFI = .91; CFI=.96; TLI=.95;

RMSEA=.05) to the observed data. Figure 8.9 illustrates this first layer of CFA Measurement Model:

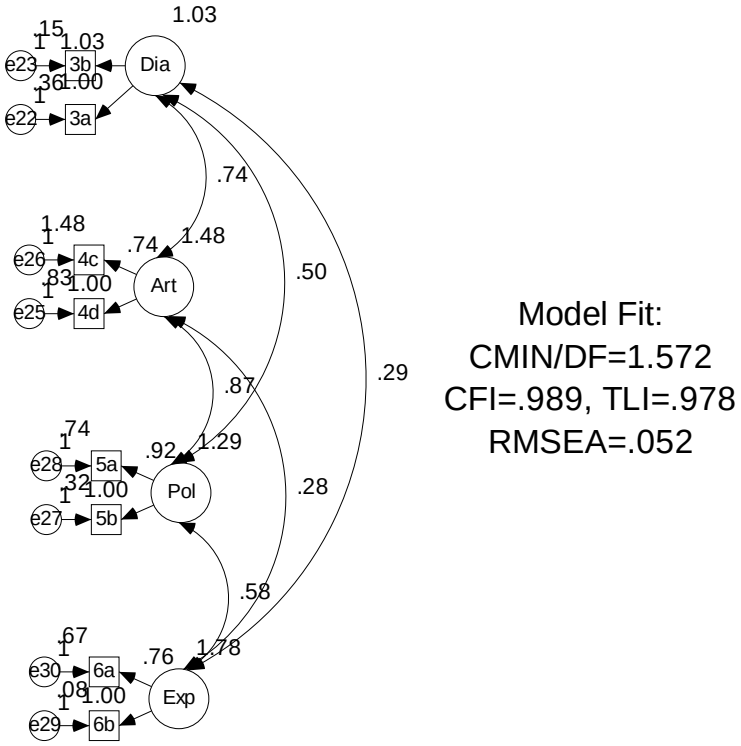

Figure 8.9: 1st layer of CFA Measurement Model

The 2nd layer: Transfer & Cross-Transformation

The second layer of the CFA model test involved two constructers Transfer and Cross-transformation, the model is dissected and the component parts are listed as below:

1. There are two contracts, as indicated by the two ellipses labelled TSF (Transfer) and CRT (Cross-Transformation).
2. Two factors are intercorrelated, as indicated by the two-headed arrows.
3. There are nine observed variables, as indicated by the 9 rectangles.
4. The observed variables load on the factors in the following patterns 8a-8c load on Factor TSF, 8d-9g load on Factor CRT. Each observed variables loads on one and only one factor.
5. Errors of measurement associated with each observed variable are uncorrelated.

The results of the CFA showed that the model fit was not desirable ((X^2/df=4.99; GFI = .92; CFI=.92; TLI=.87; RMSEA=.14). Misfit in the model was detected by assessing residuals (> ±2.58) at a 0.05 level and modification indexes (> 3.84). Item 8c and item 8d were found with high MI value. The researcher found that item 8c could be redundant when item 8a and 8b were valid, and decided to remove item 8c from the variable the Transfer. The researcher also found that item 8d might not be needed for the variable the Cross-transformation, and removed item 8d. CFA model was run to test the model fit again. The results of the CFA model after modification showed that all factor loadings (standardised regression loadings) were higher than 0.54 and all critical ratios (t-values) are significant at p=0.001 level. The model fit indices suggest the proposed measurement model achieved a good fit (X^2/df=1.377; GFI =.990; CFI=.996; TLI=.991; RMSEA=.042) to the observed data. Figure 8.10 illustrates this CFA Measurement Model:

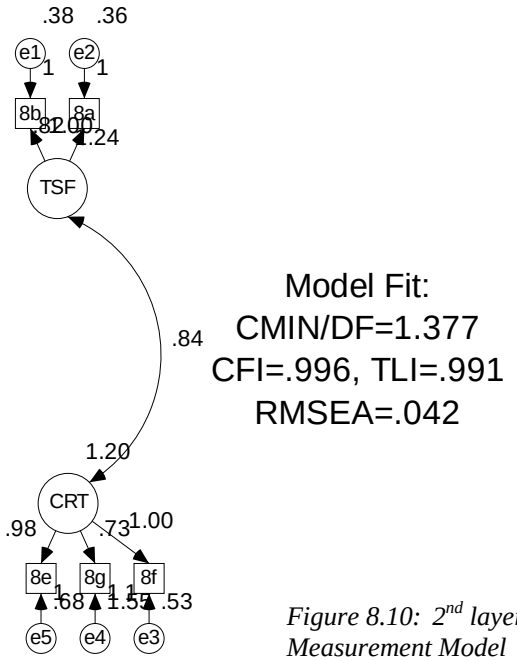

Figure 8.10: 2nd layer of CFA Measurement Model

The 3rd layer: Uncertainty Reduction and Speed-to-Market

The third layer of the CFA model test involved five dependent constructers the model is dissected and the component parts are listed as follows:

1. There are two contracts, as indicated by the two ellipses labelled UNC-cus (Uncertainty Reduction in Customer), UNC-tec (Uncertainty Reduction in Technology), UNC-com (Uncertainty Reduction in Competition), UNC-res (Uncertainty Reduction in Resources) and SP (Speed-to-Market).
2. Five factors are intercorrelated, as indicated by the two-headed arrows.
3. There are fifty observed variables, as indicated by the 15 rectangles.
4. The observed variables load on the factors in the following patterns 9a-9c load on Factor UNC-cus, 9d-9f load on Factor UNC-tec, 9g-9h load on Factor UNC-com, 9k-9i load on Factor UNC-res, and 10-10d load on Factor SP. Each observed variables loads on one and only one factor.
5. Errors of measurement associated with each observed variable are uncorrelated.

The results of the CFA showed that the model fit was not desirable ((X^2/df=3.321; GFI = .859; CFI=.905; TLI=.876; RMSEA=.105). Misfit in the model was detected by assessing residuals (> ±2.58) at a 0.05 level and modification indexes (> 3.84). Some items were found needed to remove from the model. After the theoretical justifications were checked, item 9c was removed from the variable UNC-cus; item 9f was removed for the variable UNC-tec; all the items were kept for UNC-com; item 9i was removed for the variable UNC-res and items 10c and 10d were removed from variable SP. CFA model was run to test the model fit again. The results of the CFA model after modification showed that all factor loadings (standardised regression loadings) were higher than 0.73 and all critical ratios (t-values) are significant at p=0.001 level. The model fit indices suggest the proposed measurement model is acceptable (X^2/df=2.445; GFI =.946; CFI=.966; TLI=.938; RMSEA=.08) to the observed data. Figure 8.11 illustrates this CFA Measurement Model:

Model Fit:
CMIN/DF=2.445
CFI=.946, TLI=.966
RMSEA=.08

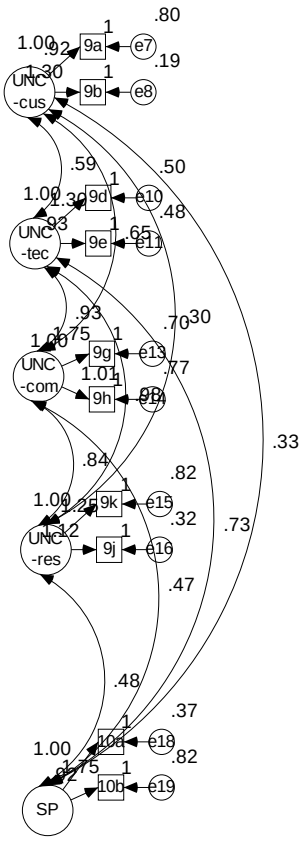

Figure 8.11: 3nd layer of CFA Measurement Model

The Final CFA Model

After three layer CFA model assessments, the final trimmed model was obtained. The results of the CFA showed that all factor loadings (standardised regression loadings) were higher than 0.57 and all critical ratios (t-values) are significant at p=0.001 level. The model fit indices suggest the proposed measurement model achieved a good fit (X^2/df=1.52; GFI = .91; CFI=.96; TLI=.95; RMSEA=.05) to the observed data. Figure 8.12 illustrates the final trimmed CFA Measurement Mode:

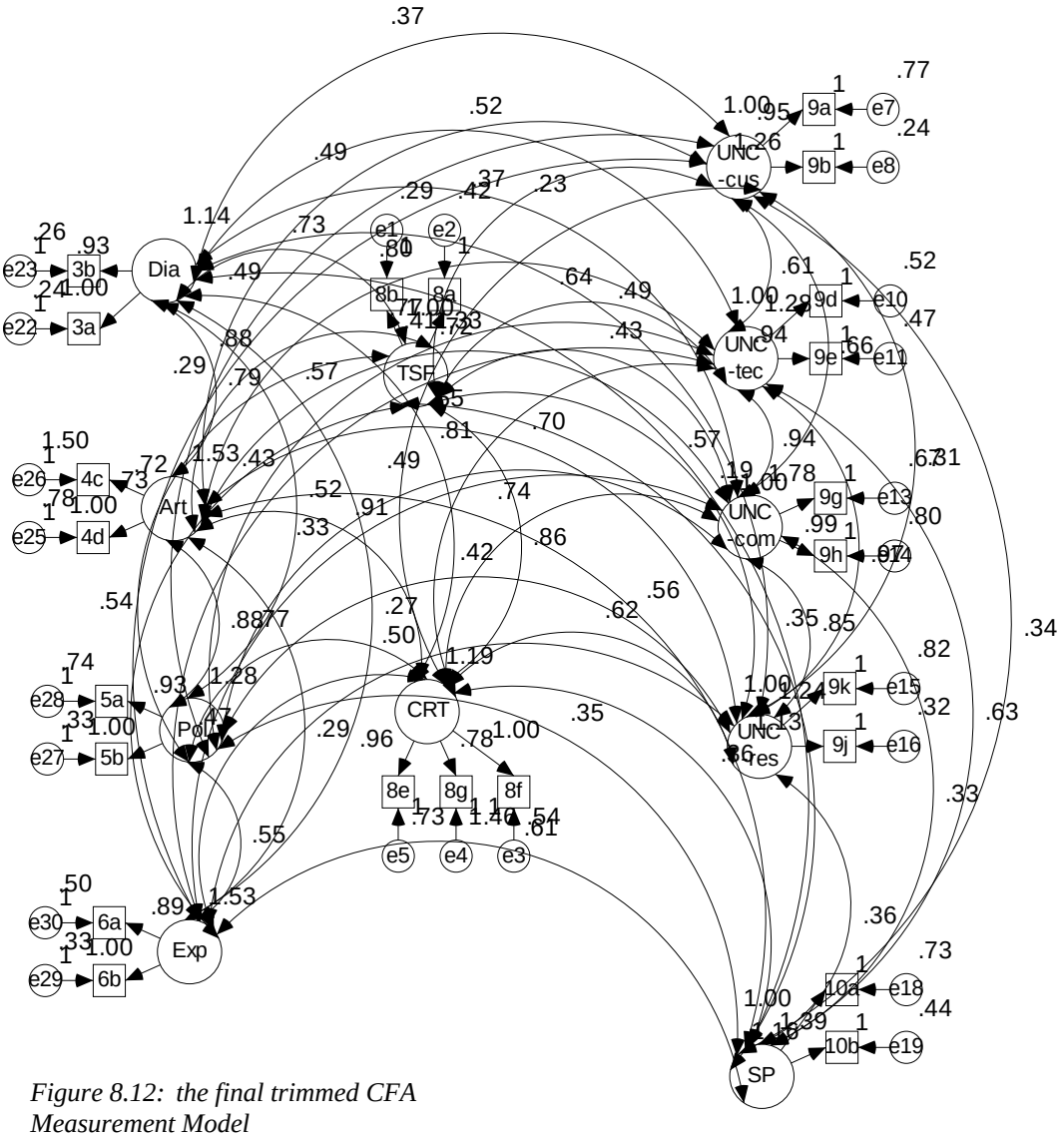

Figure 8.12: the final trimmed CFA Measurement Model

In terms of the reliability assessment, both composite reliability (all above 0.60) and AVE (all above 0.50) are beyond acceptable cut-off points. As to the discriminant validity, within all pairs of constructs the shared variance observed is lower than the minimum of their AVEs. The discriminant validity is evidenced. The following table details the model's descriptive statistics and correlations for constructs. More details can be found in the appendix: the constructs summary table, the table for composite reliability and AVE and the table for discriminant validity.

Table 8.1: Descriptive Statistics and Correlations for Constructs

	Variable	Mean	S.D.	1 (Dia)	2 (Art)	3 (Pol)	4 (Exp)	5 (TSF)	6 (CRT)	7 (U-cus)	8 (U-tec)	9 (U-com)	10(U-re)	11 (SP)
1	Dialogue	5.69	1.09	1.00										
2	Articulation	4.62	1.31	0.60***	1.00									
3	Pollination	4.56	1.21	0.43***	0.63***	1.00								
4	Experience	4.88	1.26	0.21**	0.19**	0.40***	1.00							
5	Transfer	4.83	1.11	0.59***	0.61***	0.56***	0.38***	1.00						
6	Cross-Transformation	4.56	1.13	0.48***	0.68***	0.63***	0.35***	0.69***	1.00					
7	Uncertainty Reduction-customer	5.24	1.21	0.35***	0.41***	0.45***	0.24**	0.33***	0.39***	1.00				
8	Uncertainty Reduction-technology	4.60	1.21	0.43***	0.57***	0.45***	0.30***	0.49***	0.66***	0.55***	1.00			
9	Uncertainty Reduction-competition	3.88	1.46	0.16**	0.44***	0.33***	0.20**	0.28**	0.51***	0.51***	0.62***	1.00		
10	Uncertainty Reduction-resources	4.71	1.30	0.41***	0.51***	0.33***	0.36***	0.45***	0.51***	0.29***	0.77***	0.57***	1.00	
11	Speed-to-Market	4.57	1.39	0.15*	0.38***	0.26**	0.42***	0.25**	0.28**	0.29***	0.47***	0.21**	0.28**	1.00
	Composite Reliability			0.89	0.66	0.82	0.87	0.85	0.77	0.83	0.83	0.83	0.83	0.85
	Average Variance Extracted			0.81	0.50	0.70	0.76	0.74	0.54	0.71	0.71	0.70	0.72	0.73

N = 211

*** p < .01

** p < .05

* p < .1

8.8 STRUCTURAL EQUATION MODEL – HYPOTHESES TESTING

Having establishing measurement models in the previous section that satisfy unidimensionality, validity and reliability requirements, this section turns to assess the path model using AMOS 17.0 program. The analyses and results are reported into two parts. The first part reports the test results of causal relationships between constructs in which hypothesis 1 to hypothesis 5 were tested. The second part of the section reports the result of the mediating effects among constructs in which hypothesis 6a to hypothesis 6i were tested.

Path Model

In this study, the causal process is depicted by a series of structural equations and the hypothesised model is tested (see Figure 8.1). The SEM fit statistics indicate that the estimated model has achieved a satisfactory fit to the data: X^2 (202) = 339.396 where DF = 202 Probability level = .000; CFI=.95; TLI=.93; RMSEA=.057. The chi-square: degree of freedom ratio is acceptable low (X^2/df=1.68). The incremental fit measures, CFI and TLI, exceed the traditional cut-off value of 0.90. The RMSEA (0.057) is suitably lower than adequate fit cut-off 0.080 (Malhotra and Birks 2007). The model then was used to test proposed hypotheses.

Hypothesis One

Hypothesis 1: Transfer positively leads to Cross-transformation.

Hypothesis Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
H1: Transfer → Cross-transformation.	0.34	3.511	***	Yes

*** significant at p<0.01
** significant at p<0.05

From the quantitative research and literature review results, this study proposes that companies learn about product development in their business networks by a process that consists of the transfer of existing knowledge, and the cross-transformation of

developed knowledge from different sources. The hypothesis one suggests that the transfer positively lead to the cross-transformation. SEM analysis showed that the correlation between the transfer and the cross-transformation was significant (standardised regression estimate (β) = 0.34 at p<0.01 level). The result indicates that respondents of this study support the hypothesis that the increase in Transfer of the existing knowledge leads to the increase of Cross-transformation of the developed knowledge from different networked partners.

Hypothesis Two

Hypothesis 2a: Dialogue positively impacts on Transfer.

Hypothesis 2b: Articulation positively impacts on Transfer.

Hypothesis 2c: Experience positively impacts on Transfer.

Hypothesis Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
H2a: Dialogue → Transfer.	0.27	2.98	**	Yes
H2b: Articulation → Transfer.	0.44	4.05	***	Yes
H2c: Experience → Transfer.	0.23	3.39	***	Yes

*** significant at p<0.01

** significant at p<0.05

The second hypothesis proposes that in product development network learning process (i.e. the transfer and the cross-transformation), companies apply dialogue, articulation and experience for the transfer of existing knowledge. This group of hypotheses (H2a, H2b and H2c) focuses on how the transfer of existing knowledge was taken place. The results indicated that the correlation between dialogue and transfer is significant (β = 0.27 p < 0.05 level); between articulation and transfer is significant (β = 0.44 p < 0.01 level); and between experience and transfer is significant (β = 0.23 p < 0.05 level). H2a, H2b and H2c thus were all supported. Furthermore, it was found that among these three antecedents, articulation (β = 0.44)

had stronger impacts on the transfer than dialogue (β = 0.27) and experience (β = 0.23) did.

Hypothesis Three

Hypothesis 3a: Articulation positively impacts on Cross-transformation.

Hypothesis 3b: Pollination positively impacts on Cross-transformation.

Hypothesis 3c: Experience positively impacts on Cross-transformation.

Hypothesis Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
H3a: Articulation → Cross-transformation.	0.37	2.73	**	Yes
H3b: Pollination → Cross-transformation.	0.24	2.38	**	Yes
H3c: Experience → Cross-transformation.	0.14	1.77	0.08	No

*** significant at p<0.01

** significant at p<0.05

The study then moved to find out how the cross-transformation was occurred. This group of hypotheses (H3a, H3b and H3c) asserts that companies apply articulation, pollination and experience for the cross-transformation of developed knowledge from different business network partners. The results indicated that direct correlation between articulation and cross-transformation was significant (β = 0.37 at p < 0.05 level). The correlation between pollination and cross-transformation was significant (β = 0.24 at p < 0.05 level). H3a and H3b were thus supported. However, the data indicated that the correlation between experience and cross-transformation was not significant (β = 0.14, t = 1.77, p = 0.08). H3c was thus not supported. It was also found that articulation had stronger impacts on cross-transformation (β = 0.37) than pollination (β = 0.24) did.

Hypothesis Four

Hypothesis 4a: Cross-transformation positively impacts on Uncertainty Reduction in customer

Hypothesis 4b: Cross-transformation positively impacts on Uncertainty Reduction in technology.

Hypothesis 4c: Cross-transformation positively impacts on Uncertainty Reduction in competition.

Hypothesis 4d: Cross-transformation positively impact on Uncertainty Reduction in resources.

Hypothesis Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
H4a: Cross-transformation → Uncertainty Reduction in customer.	0.44	4.89	***	Yes
H4b: Cross-transformation → Uncertainty Reduction in technology.	0.69	8.45	***	Yes
H4c: Cross-transformation → Uncertainty Reduction in competition.	0.50	6.01	***	Yes
H4d: Cross-transformation → Uncertainty Reduction in resources.	0.56	6.48	***	Yes

*** significant at $p<0.01$

** significant at $p<0.05$

Hypothesis four tests the relationship between the cross-transformation and uncertainty reduction. It is proposed that cross-transformation positively contributes to the uncertainty reduction in four major areas - customer (H4a), technology (H4b), competition (H4c) and resources (H4d). The data provide empirical support for these four hypotheses. As shown in the table, the correlation between cross-transformation and uncertainty reduction in customer is significant ($\beta = 0.44$ at $p < 0.01$ level); between cross-transformation and uncertainty reduction in technology is significant ($\beta = 0.69$ at $p < 0.01$ level); between cross-transformation and uncertainty reduction in competition is significant ($\beta = 0.50$ at $p < 0.01$ level); and between cross-transformation and uncertainty reduction in resources is also significant ($\beta = 0.56$ at $p < 0.01$ level). H4a, H4b, H4c and H4d were thus all supported. The data also indicated that among four areas in uncertainty reduction, cross-transformation had

the strongest impacts on the technology uncertainty reduction (β = 0.69), followed by resources (β = 0.56), competition (β = 0.50) and customer (β = 0.44).

Hypothesis Five

Hypothesis 5: Cross-transformation positively impacts on speed-to-market

Hypothesis Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
H5: Cross-transformation → speed-to-market	0.34	4.23	***	Yes

*** significant at p<0.01
** significant at p<0.05

Hypothesis five focuses on the relationship between cross-transformation and speed-to-market. The result indicated that the correlation between cross-transformation and speed-to-market is significant (β = 0.34 at p<0.01 level). H5 was supported.

Result of Path Model

In total, there were twelve hypotheses in testing twelve direct associations between constructs. The data provided empirical support to eleven hypotheses except hypothesis H3c (experience impacts on cross-transformation) was not supported. Figure 8.13 summarises these results:

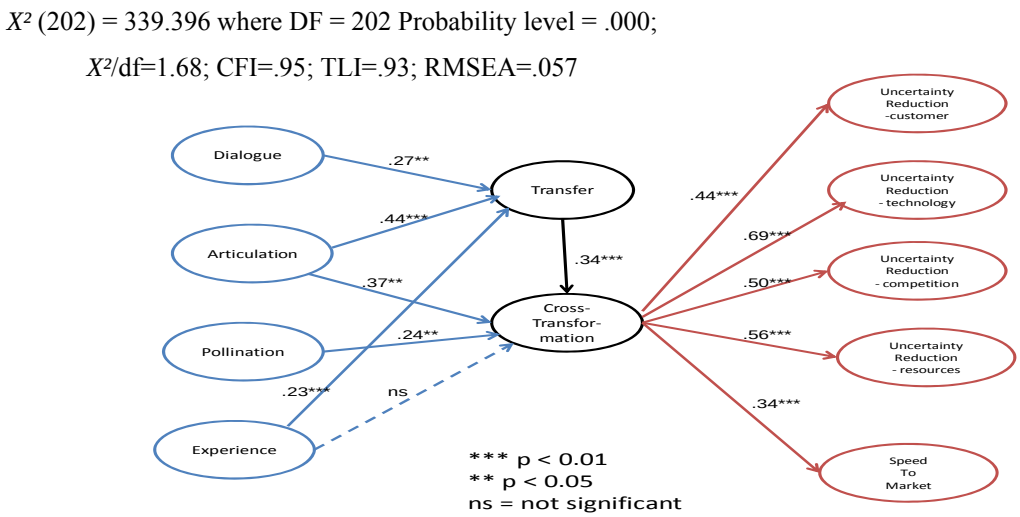

Figure 8.13: SEM Results (Source: Author)

Mediating Effects

In the study, a mediating effect was detected and assessed. The mediating effect in this case involved two mediators – the transfer and the cross-transformation. The procedure for testing moderation suggested by Baron and Kenny (1986) was used (also see Holmback 1997; Song, Xie and Dyer 2000). Testing results showed that the transfer fully mediated the effect of dialogue and experience on the cross-transformation; and partially mediated the effect of articulation on the cross-transformation. The transfer had no mediation effect of pollination on the cross-transformation. Further, testing results showed that the cross-transformation fully mediated the effect of the transfer on uncertainty reductions (four areas) and speed-to-market. Results indicated that in the NPD network learning process, dialogue, articulation and experience affects the cross-transformation when the transfer is taken into account, and in turn affects uncertainty reduction and speed-to-market. Results suggest that in the NPD network learning, the transfer of knowledge is necessary; yet it is the cross-transformation that impacts on the uncertainty reduction and speed-to-market.

Mediating effects highlight the importance of postulating entities or processes that intervene between input and output (Baron and Kenny 1986). The most generic formulation of a mediation hypothesis can trace back to Woodworth (1928) who recognised that an active organism intervenes between stimulus and response. The central idea of his model is that the effects of stimuli on behaviour are mediated by various transformation processes internal to the organism. To understand the effects of the DAPE (as the input) are mediated by the transfer and the cross-transformation of knowledge to uncertainty reduction and speed-to-market (as the output), this thesis adopted Woodworth's mediation theory and further assesses the mediating effects with the transfer and the cross-transformation as multiple mediators. The sixth group of proposition and the hypotheses are as below:

Proposition 6

In the NPD network learning process, Dialogue, Articulation, and Experience affect the Cross-transformation when the Transfer is taken into account, and in turn affect Uncertainty Reduction and Speed-to-Market.

Hypothesis 6a: Transfer mediates the effect of Dialogue on Cross-transformation.

Hypothesis 6b: Transfer mediates the effect of Articulation on Cross-transformation.

Hypothesis 6c: Transfer does not mediate the effect of Pollination on Cross-transformation.

Hypothesis 6d: Transfer mediates the effect of Experience on Cross-transformation.

Hypothesis 6e: Cross-transformation mediates the effect of Transfer on Uncertainty Reduction – customer.

Hypothesis 6f: Cross-transformation mediates the effect of Transfer on Uncertainty Reduction – technology.

Hypothesis 6g: Cross-transformation mediates the effect of Transfer on Uncertainty Reduction – competitor.

Hypothesis 6h: Cross-transformation mediates the effect of Transfer on Uncertainty Reduction – resources.

Hypothesis 6i: Cross-transformation mediates the effect of Transfer on Speed-to-Market.

Figure 8.14 summaries the proposed hypotheses for the mediating effects:

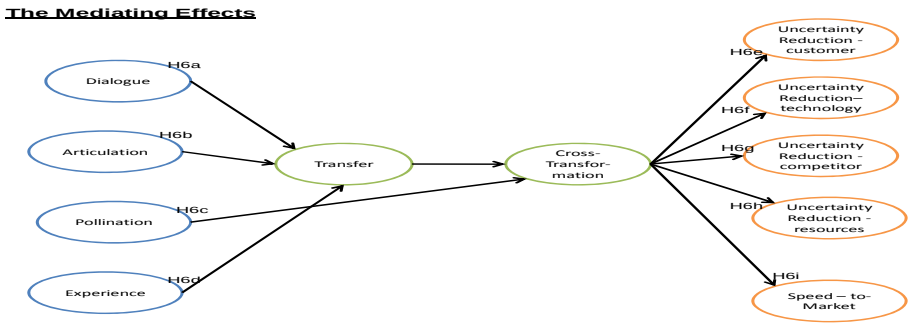

Figure 8.14: The Mediating Effect Framework (Source: Author)

The procedure for testing moderation proposed by Baron and Kenny (1986) was adopted (also see Holmback 1997; Song, Xie and Dyer 2000). To satisfy the mediating effects, Baron and Kenny (1986) suggest that four conditions must hold: (1) the predictor variables significantly impact the mediator in the expected direction; (2) the mediator significantly impacts the dependent construct in the expected direction; (3) the predictor variables significantly impact the dependent construct in the expected direction; and (4) after controlling for the effects of the mediator, the impact of the predictor variables on the dependent construct is not significantly different from zero (for full mediation) or significantly reduced (for partial mediation). In testing mediating effect with multiple mediators, this study conducted two sets of path model tests. One set was having the Transfer as mediator, DAPE as antecedent variables, and Cross-transformation as dependent variable. Another set was having the Cross-transformation as mediator, the Transfer as antecedent, Uncertainty Reduction and Speed-to-Market as dependent variables. Testing steps and results are reported as below.

The Transfer as Mediator

Model 1-1: The predictor variables (DAPE) significantly impact the mediator (transfer) in the expected direction.

Model Fit: X^2/df=1.32; CFI=.99; TLI=.99; RMSEA=.039.

Path Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
Dialogue → Transfer	0.29	3.32	***	Yes
Articulation → Transfer	0.30	2.25	**	Yes
Pollination → Transfer	0.17	1.64	.10	No
Experience → Transfer	0.18	2.51	**	Yes

*** significant at p<0.01

** significant at p<0.05

The results of the above table show that dialogue (β=.29, p<.01), articulation (β=.30, p<.05) and experience (β=.18 p<.05) significantly affect the transfer. Pollination (β=.17, p=.10) insignificantly affect the transfer.

Model 1-2: The mediator (transfer) significantly impacts the dependent variable (cross-transformation) in the expected direction.

Model Fit: X^2/df=1.38; CFI=.996; TLI=.991; RMSEA=.042.

Hypothesis Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
Transfer → Cross Transformation	0.69	8.25	***	Yes

*** significant at p<0.01
** significant at p<0.05

The results of the above table show that the transfer (β=.69, p<.01) significantly affect the cross-transformation.

Model 1-3: The predictor variables (DAPE) significantly impact the dependent variable (cross-transformation) in the expected direction.

Model Fit: X^2/df=1.96; CFI=.97; TLI=.95; RMSEA=.068.

Path Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
Dialogue → Cross-Transf.	0.05	0.48	.63	No
Articulation → Cross-Transf.	0.48	2.69	**	Yes
Pollination → Cross-Transf.	0.26	2.08	**	Yes
Experience → Cross-Transf.	0.13	1.74	.08	No

*** significant at p<0.01
** significant at p<0.05

The results of the above table show that dialogue (β=.05, p=.63) and experience (β=.13, p=.08) do not significantly affect the cross-transformation. Articulation (β=.48 p<.05) and Pollination (β=.26, p<0.05) significantly affect the transfer.

The Cross-Transformation as Mediator

The study then moves on to test another mediating effect of having cross-transformation as mediator.

Model 2-1: The predictor variables (transfer) significantly impact the mediator (cross-transformation) in the expected direction. This path had been tested in Model 1-2. The results showed that the transfer (β=.69, p<.01) significantly affect the cross-transformation.

Model 2-2: The mediator (cross-transformation) significantly impacts the dependent variables (uncertainty reduction and speed-to-market) in the expected direction.

Model Fit: X^2/df=1.92; CFI=.97; TLI=.95; RMSEA=.066.

Path Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
Cross-Transf. → Uncertainty Reduction - customer	0.37	4.22	***	Yes
Cross-Transf. → Uncertainty Reduction - technology	0.65	7.82	***	Yes
Cross-Transf. → Uncertainty Reduction - competition	0.51	5.96	***	Yes
Cross-Transf. → Uncertainty Reduction - resources	0.51	5.85	***	Yes
Cross-Transf. → Speed-to-Market	0.31	3.80	***	Yes

*** significant at p<0.01

** significant at p<0.05

The results of the above table show that the cross-transformation significantly affect uncertainty reduction in customer (β=.37, p<.01), uncertainty reduction in technology (β=.65, p<.01), uncertainty reduction in competition (β=.51, p<.01),

uncertainty reduction in resources (β=.51, p<.01) and speed-to-market (β=.31, p<.01).

Model 2-3: The predictor variable (transfer) significantly impacts the dependent variables (uncertainty reduction and speed-to-market) in the expected direction.

Model Fit: X^2/df=1.76; CFI=.98; TLI=.96; RMSEA=.060

Path Tested	Standardised Estimate (β)	Critical Ratio (t)	p value	Supported
Transfer → Uncertainty Reduction - customer	0.34	3.88	***	Yes
Transfer → Uncertainty Reduction - technology	0.49	5.76	***	Yes
Transfer → Uncertainty Reduction - competition	0.28	3.35	***	Yes
Transfer → Uncertainty Reduction - resources	0.45	5.14	***	Yes
Transfer → Speed-to-Market	0.26	3.17	**	Yes

*** significant at p<0.01
** significant at p<0.05

The results of the above table show that the transfer significantly affect uncertainty reduction in customer (β=.34, p<.01), uncertainty reduction in technology (β=.49, p<.01), uncertainty reduction in competition (β=.28, p<.01), uncertainty reduction in resources (β=.45, p<.01) and speed-to-market (β=.26, p<.05).

Overall Model: Multiple-Mediators

After controlling the effects of the mediator, if the impact of the predictor variables on the dependent variables is not significantly different from zero then the full mediation is supported; if correlation value is significantly reduced then the partial mediation is supported; otherwise no mediation effect is supported. Based on the results of previous models, the final model ran all the model paths again to verify the mediating effects of this multiple-mediator model. Using Baron and Kenny's (1986) criteria, the researcher found empirical support for the hypothesised mediating effects:

Mediation Hypothesis Tested	If the effects of mediator is controlled?	Effects of Antecedents (DAPE) ↓ Dependent (Cross-T)	Supported
H6a: Transfer mediates the effect of dialogue on cross-transformation	Yes (Dialogue --> Transfer: 0.31**; Transfer --> Cross-Transf.: 0.33**)	ns	Yes (Full mediation)
H6b: Transfer mediates the effect of articulation on cross-transformation	Yes (Articulation --> Transfer: 030**; Transfer --> Cross-Transf.: 0.33**)	Articulation --> Cross-Transf. (0.43**)	Yes (Partial mediation)
H6c: Transfer does not mediate the effect of pollination on cross-transf.	No (Pollination --> Transfer: ns)	Pollination --> Cross-Transf. (0.26**)	Yes (No mediation)
H6d: Transfer mediates the effect of experience on cross-transformation	Yes (Experience --> Transfer: 0.20**; Transfer --> Cross-Transf.: 0.33**)	ns	Yes (Full mediation)
H6e: Cross-transf. mediates the effect of transfer on Uncertainty Reduction - customer	Yes (Transfer--> Cross-T: 0.33**; Cross-T --> Uncertainty Reduct. - customer: 0.35**)	ns	Yes (Full mediation)
H6f: Cross-transf. mediates the effect of transfer on Uncertainty Reduction - technology	Yes (Transfer--> Cross-T: 0.33**; Cross-T --> Uncertainty Reduct. – tech.: 0.64***)	ns	Yes (Full mediation)
H6g: Cross-transf. mediates the effect of transfer on Uncertainty Reduction - competition	Yes (Transfer--> Cross-T: 0.33**; Cross-T --> Uncertainty Reduct. – compet.: 0.65***)	ns	Yes (Full mediation)
H6h: Cross-transf. mediates the effect of transfer on Uncertainty Reduction - resources	Yes (Transfer--> Cross-T: 0.33**; Cross-T --> Uncertainty Reduct. - resources: 0.41***)	ns	Yes (Full mediation)
H6i: Cross-transf. mediates the effect of transfer on Speed-to-Market	Yes (Transfer--> Cross-T: 0.33**; Cross-T --> Speed-to Market: 0.30**)	ns	Yes (Full mediation)

** significant at $p<0.05$
ns: not significant

The results of the above table showed that after the controlling the effects of the mediator (i.e. the effect of dialogue → transfer is significant (β=.31, p<.05); transfer → cross-transformation is significant (β=.33, p<.05)), the impact of the predictor variable (dialogue) on the dependent variable (cross-transformation) is however not significant. H6a therefore is supported with evidence of full mediation.

The same results applied to meditation effect of experience → transfer → cross-transformation. The effect of experience → transfer is significant (β=.20, p<.05) and of transfer → cross-transformation is significant (β=.33, p<.05), yet of experience → cross-transformation is not significant. H6b thus is supported as full mediation.

As to the effects of articulation → transfer → cross-transformation, the effect of the mediator is significant (articulation → transfer (β=.30, p<.05) and transfer → cross-transformation (β=.33, p<.05)) and the impact of the predictor (articulation) on the dependent variable (cross-transformation) is also significant (β=.43, p<.05). It was also found that the correlation value of articulation → cross-transformation is reduced from 0.48** in model 1-3 to 0.43** in the final model. H6c is supported as partial mediation.

H6d hypothesizes there is no mediating effect of pollination → transfer → cross-transformation. As shown on the above table, the effect of the mediator (transfer) is not significant; therefore, H6d is supported as no mediation.

As to hypothesis 6e – 6i, full mediation in these five hypotheses was found. The effect of transfer → cross-transformation is significant (β=.33, p<.05) and of cross-transformation → uncertainty reduction-customer is significant (β=.35, p<.05), yet of transfer → uncertainty reduction-customer is not significant. H6e is therefore supported. As to H6f, the effect of transfer → cross-transformation is significant (β=.33, p<.05) and of cross-transformation → uncertainty reduction-technology is significant (β=.64, p<.01), yet of transfer → uncertainty reduction-technology is not significant. H6f is therefore supported. For H6g, the effect of transfer → cross-

transformation is significant (β=.33, p<.05) and of cross-transformation → uncertainty reduction-competition is significant (β=.65, p<.01), yet of transfer → uncertainty reduction-competition is not significant. H6f is therefore supported. Same for H6h, the effect of transfer → cross-transformation is significant (β=.33, p<.05) and of cross-transformation → uncertainty reduction-resources is significant (β=.41, p<.01), yet of transfer → uncertainty reduction-resources is not significant. H6h is therefore supported. Finally, for H6i, The effect of transfer → cross-transformation is significant (β=.33, p<.05) and of cross-transformation → speed-to-market is significant (β=.30, p<.05), yet of transfer → speed-to-market is not significant. H6i is therefore supported. Figure 8.15 summaries the reported results:

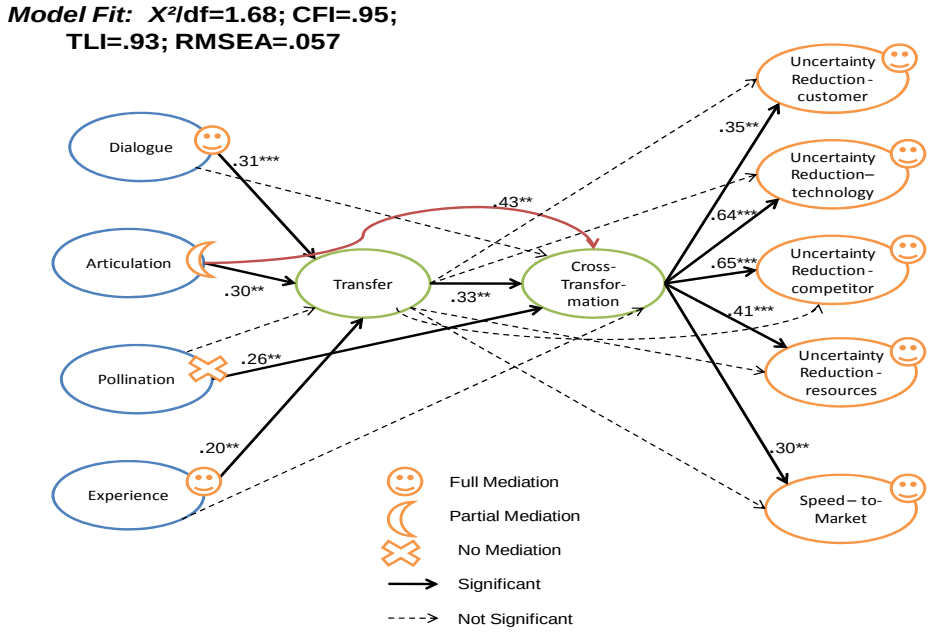

Figure 8.15: Mediating Effect Results (Source: Author)

8.9 CONCLUSION

Learning processes are intrinsically social and collective phenomena. To cope with rapid changing and uncertainty, firms ability to transfer and cross-transform knowledge with network business partners is essential in developing products. These phenomena have been supported by the respondents of a field survey conducted in this study. 211 usable samples were collected in the UK. Collected data were careful examined. The data preparation and screening included the procedure of data

collection, the treatment the non-response bias and the missing data, the detection of outliers, multicollinearity, and normality. The results showed that, via ANOVA test, the non-response bias was not an issue. The amount of missing data was with random missing pattern. The EM approach was applied as a remedy. As to the outliers, there were some but it was decided to retain to ascertain the generalisability. Normal probability plots, residual scatterplots were checked. Results showed normality, linearity were with no serious concerns. Multicollinearity was examined by testing discriminant validity (Grewal et al. 2004). No concern was detected.

In this study, respondents were mainly from industries of hi-tech and e-business (25%), chemicals and pharmaceuticals (15%), food and Beverages (12%), consultancy/research/training (11%), and Machinery & Equipment (10%). 57% of respondents were from small business with less than 50 staff. 16% of respondents were from large business with more than 500 staff. Respondents were mainly from business to business sectors (74%). In this study, 37% respondents were selling physical goods, 29% were providing services and 34% were mixed. Finally, 51% of the respondents were owner or chief executive of the company, 16% were working in marketing or sales and 15% were working in product development areas.

The survey research concerned respondents experience on successful product development project(s) in the past three years. The descriptive analysis detailed the mean values and associated standard deviation for items in the model constructs. The results first revealed the extent of the importance of various network partners and the extent of those important network partner involvements in various product development processes. The results showed that the customers were rated as the most important alliances among all the listed network partners, followed by suppliers and joint ventures. The study indicated that companies involved network partners at every stages in the product development process (mean values 3.96 – 5.10). Respondents also indicated that the company most often involved network partners in the process of developing new products according to market needs; and comparative less in the process of finding competitors moves.

The Cronbach's Alphas were checked for reliability of all the constructs items and the results revealed that alpha values were all above .7 threshold (Hair et al. 1998) indicating there was no major concern on the accuracy of the measuring instrument. Survey results showed positive feedback almost on all the testing items. 33 out of total 36 items had mean values greater than 4 (in a 7 points scale). The highest mean value was 5.65 in one of the items in the construct – the transfer of existing knowledge. The lowest mean value was 3.80 (out of 7) in one of the items in uncertainty reduction – competition.

For structural equation modelling (SEM) analysis, CFA model provided powerful evaluation on unidimensionality, construct validity and reliability. The measurement model was then evaluated. Eleven latent constructs were validated by three separated confirmatory factor analysis (CFA) models. A trimmed CFA model was obtained after model modification. Unidimensionality (model fit), reliability and discriminant validity were also examined. The CFA analysis satisfied the unidimensionality, reliability, convergent validity and discriminant validity. A constructs summary table which summaries all the constructs with their incorporated items, mean values, standard deviation, standardised regression weight, Alpha value, Composite Reliability, Average Variance Extracted and the correlations matrix for constructs, can be found in the appendix.

Finally, hypotheses were tested. The results showed that in the product development network learning, the transfer of existing knowledge leads to the cross-transformation of advanced knowledge. Hypothesis one was supported. The data also provided empirical support for this study's hypotheses regarding the transfer of knowledge. That is, in the product development network learning process, companies employ dialogue, articulation and experience for the transfer of existing, Hypothesis two was supported. It was also found that among these three factors, articulation had strongest impacts on the transfer. As to the cross-transformation, it was found that companies apply articulation and pollination for the cross-transformation of developed knowledge. However, the impact of experience on cross-transformation was found not significant. Thus, hypotheses 3a and 3b were

supported, yet hypothesis 3c was not supported. It was also found that articulation had stronger influences on cross-transformation than pollination did. Furthermore, the results showed that the impacts of cross-transformation on uncertainty reduction in customer, technology, competition and resources as well as on speed-to-market were all significant. Hypotheses four and five were thus supported. It was also found that among four areas in uncertainty reduction, technology uncertainty reduction was impacted the most by cross-transformation.

A mediating effect with multiple-mediators was found. To assess mediation of a multiple-mediator model, the results indicated that transfer mediates the effect of dialogue, articulation and experience on cross-transformation, and cross-transformation mediates the effect of transfer on uncertainty reduction and speed-to-market. The proposition that in the product development network learning process, DAPE affects the cross-transformation when the transfer is taken into account, and in turn affects uncertainty reduction and speed-to-market, is then supported. It was also found that H6b (articulation → transfer → cross-transformation) was supported as partial mediation and H6c (pollination → transfer → cross-transformation) was supported as no mediation. All the other hypotheses in this group were supported as full mediation.

CHAPTER 9

DISCUSSION AND CONCLUSION

CHAPTER NINE

9.0 Introduction

9.1 Research Summary

9.2 Discussion

NPD Network Learning Process

- The transfer and cross-transformation of knowledge

DAPE

Uncertainty Reduction and Speed-to-Market

Mediating Effects

9.3 Contribution

9.4 Managerial Implications

9.5 Conclusion

9.6 Limitations

9.7 Future Research

9.0 INTRODUCTION

This chapter aims to discuss the findings from the mixed-methods approach, the thesis' major implications and its contribution to theory and practice. It first summarises current research's objectives and its results. The chapter then discusses the findings that are built on empirical evidence and the related theories and key assumptions in the literature. Emergent themes are backed up with examples from the three cases studies and results of survey research. Gaps and contradictions from the related theories and key assumptions in the extant literature are presented and discussed. This chapter concludes by detailing the contribution, managerial implications, limitations and directions for further research.

9.1 RESEARCH SUMMARY

The point of departure for the present study is that although there is much evidence that a firm's new product development (NPD) is a result of inter-firm learning in collaborating networks, the question of how inter-firm learning takes place in NPD networks is less understood. It addresses the following research questions: how is business network learning processed in NPD; how do firms engage with their business alliances in this process; and how does this process impact on uncertainty reduction and speed-to-market in NPD?

To find out how firms learn about NPD in their business networks, two complementary research approaches were envisaged to explore empirical phenomena and to examine the proposed constructs: qualitative research using in-depth interviews and multiple-case studies to guide and refine theory development, and survey research using the key informant approach to assess the substantive validity of the findings that were developed from the qualitative research. Table 9.1 shows a summary of the present study by its research objectives, questions/hypotheses, method(s) and results:

Summary of the Study

Objective	Questions / Hypotheses	Methods	Results
Objective 1: To empirically investigate industrial practice on how business network learning is processed in successful NPD.	Q1: How is business network learning processed in successful NPD?	Multiple Case Study	Proposition1: Companies learn about NPD in their business networks by a process of the transfer and the cross-transformation of knowledge. This transfer positively leads to the cross-transformation.
Objective 2: To empirically investigate industry practice on how firms engage with their business alliances in the business network learning process.	Q2: How do firms engage with their business alliances in the NPD network learning process?	Multiple Case Study	Proposition 2: In the NPD network learning process, companies engage in dialogue, articulation, and experience for the transfer of knowledge. Proposition 3: In the NPD network learning process, companies engage in pollination, articulation, and experience for the cross-transformation of knowledge. Proposition 4: In the NPD network learning process, the cross-transformation positively contributes to uncertainty reduction. Proposition 5: In the NPD network learning process, the cross-transformation positively contributes to speed-to-market.

Objective 3: To empirically investigate industry practice on how NPD network learning impacts on uncertainty reduction and speed-to-market.	Q3: how does the business network learning mechanism impact on NPD uncertainty reduction and speed-to-market?	Multiple case study	Proposition 4: In the NPD network learning process, the cross-transformation positively contributes to uncertainty reduction. P5: In the NPD network learning process, the cross-transformation positively contributes to speed-to-market.
Objective 4: To propose a theoretical model of business network learning in NPD from the empirical evidence.	A theoretical model is built (see Figure 7.6)	Cross-case pattern match and extant literature	Proposition 1 to 5--> H1, H2a, H2b, H2c, H3a, H3b, H3c, H4a, H4b, H4c, H4d, H5
Objective 5: To empirically test the proposed theoretical model with large sample	H1, H2a, H2b, H2c, H3a, H3b, H3c	Survey Research	Supported: H1, H2a, H2b, H2c, H3a, H3b Not supported: H3c
Objective 6: To empirically examine the impact on uncertainty reduction and speed-to-market in NPD.	H4a, H4b, H4c, H4d, and H5	Survey Research	Supported: H4a, H4b, H4c, H4d, and H5
Objective 7: To contribute theoretical conclusions and practice recommendations from the integrated theoretical studies and empirical evidence.	How do firms learn about NPD in their business networks?	Interpretation and extant literature	Conclusion: 1) NPD network learning: the transfer + the cross-transformation of knowledge ; 2) Firms engage dialogue, articulation and experience for the transfer; 3) Application of the transfer , and engagement of pollination and

			articulation are essential to the cross-transformation; 4) Transfer is necessary but insufficient; it is the cross-transformation contributes to uncertainty reduction and speed-to market in NPD.

Table 9.1: Research Summary (Source: Author)

9.2 DISCUSSION

This section discusses results from the three case studies and survey research, together with related theories and key assumptions in the literature. The discussion commences from the proposed NPD network learning process that contains knowledge transfer and knowledge cross-transformation. It then moves to the four antecedents - dialogue, articulation, pollination and experience, and their impacts on the suggested NPD network learning process model, followed by the discussion about the impacts on two important NPD performance attributes – uncertainty reduction and speed-to-market.

NPD Network Learning Process

Knowledge Transfer

The qualitative case study suggested two particular phenomena pertinent to understanding the process of the learning process in NPD network collaboration. First, qualitative data indicates that learning in NPD networks starts from accessing and collecting knowledge (or information) from firms' business network partners. As one of the informants described: …*Listen to our customers! Customers are fantastic levellers! We had made one big mistake once that we cut off our customers,*

trying to come up new ideas from our own corner. Doesn't work! It just doesn't work. We need to listen to our business partners. We need the information and know-how, especially from our customers…. The thesis terms these important activities in NPD network learning, the 'transfer' of knowledge (Cyert and March 1963; Cohen and Levinthal 1990; Inkpen 2000). Data from the three case studies indicate that the activities of the 'transfer' of knowledge in NPD collaborative projects repeatedly appeared. In examining companies' involvement in knowledge transfer and cross-transformation, data of the survey research indicate companies' high extent of knowledge transfer involvement on all the items of this variable with mean values: 4.86-4.97 out of 7 points.

In the learning literature, knowledge transfer has been viewed as the centre of a firm's processes between a parent company and its alliances (Inkpen 1996; Marsh and Stock 2003; Carlile 2004). Knowledge transfer as a concept has its deep roots in the literature of learning – the process of accessing, assimilating, and disseminating information (Cyert and March 1963; Daft and Weick 1984; Cohen and Levinthal 1990; Moorman 1995; Inkpen 2000). The concept of 'transfer' has its basis in the information-processing approaches to boundaries in organisation theory (Lawrence and Lorsch 1967; Galbraith 1973). The primary concern is one of 'processing' or transferring knowledge across it. The information-processing approach has been the dominant view used to describe managing of a firm's learning (Slater and Narver 1995; Sinkula 1994). It is noteworthy that the information-processing approach, however, has been argued by researchers who adopt an interpretive approach as problematic when novelty accounts some differences and when knowledge is tacit (Polyani 1966) and difficult to get across companies' boundaries (Nonaka and Takeuchi 1995).

Researchers with interpretive views recognise how different domains (i.e. thought worlds) naturally generate interpretive differences and so emphasize processes that help create 'shared meanings' (Dougherty 1992) or mechanisms to reconcile discrepancies in meaning to accommodate knowledge transfer (Nanaka and Takeuchi 1995). This is distinguished from researchers who stress the theory of information-

processing. This group of researchers have paid attention to the distinction between tacit and explicit knowledge and have recognised the situated and interpretive challenges of moving knowledge across boundaries (Nonaka and Takeuchi 1995; Spender 1996; von Hippel 1994). For example, von Hippel and Tyre's work (von Hippel 1994, Tyre and von Hipple 1997) calls attention to the stickiness of situated knowledge when trying to move it across different domains. In studying knowledge transfer, Nonaka (1994) suggests the process of 'externalisation' and Hedlund (1994) discusses the process of 'articulation'. Both theories help to understand the process of making tacit knowledge explicit. This group of researchers not only acknowledges but appreciates the importance of interpretive differences across boundaries in knowledge transfer. In the present study, empirical evidence suggests that knowledge transfer is a process of accessing, assimilating and disseminating as claimed by researchers, with an information-processing approach. Further, in implementing knowledge transfer, current research indicates that companies' turning tacit knowledge explicit is indeed critical as described by researchers with interpretive views – a phenomenon of 'articulation' engagement as termed by current research. This is discussed in more detail in the following section.

Knowledge Cross-Transformation

In studying how firms learn in NPD networks, data of the three case studies reveal an important phenomenon after knowledge transfer: companies bring back different knowledge from different network alliances, work on the collected knowledge, develop advanced or new knowledge, and then share the advanced/new knowledge back with network allies. This phenomenon is found across firms' NPD collaboration networks. As described by an informant from an e-Business case: *It is a rich 'fusion' approach that makes our company unique – all the combinations mixing into it. It is the culture to work together, listen to each other, and help companies in the entire supply chain do the same thing. By this way, we all win.*…Current research terms the phenomenon 'knowledge cross-transformation'.

In examining companies' involvement in knowledge cross-transformation, results of the survey research indicate companies' high extent of involvement in knowledge

cross-transformation on all the items of this variable with average means of: 4.45-4.69 out of 7.0 points. Further, results of structural equation modelling indicate that firms' application of knowledge transfer positive leads to knowledge cross-transformation with standardised regression estimate (β) = 0.34 at $p<0.01$ level.

The idea of 'knowledge transformation' has caused researchers' attention in recent years. In relation to assimilating new knowledge, Bechky (2003) explains the knowledge transformation as it occurred 'when a member of one community came to understand new knowledge from another community fit within the context of his own work, enriching and altering what he knew' (Bechky 2003, p.321). In knowledge transformation, the understanding (e.g. of the product, process, or organisation) is expanded, not merely by the introduction of new knowledge 'transferred' by a partner firm, but by putting that knowledge to use in such a way that it induces a new light. It is seen that the ability of knowledge transformation creates broader shared minds (Halme 2001; Pyka 2002).

Scholars and researchers have provided some theoretical discussion on the phenomena of 'knowledge cross-transformation', that is, companies bring back different types of knowledge, work on the collected knowledge, develop advanced/new knowledge, and then share the advanced/new knowledge back through network alliances that were found in the present study (e.g. Cohen and Levinthal 1990; Teece et al. 1997; Halme 2001; Beamish and Berdrow 2003). For example, the dynamic capabilities approach (Teece et al. 1997) highlights a firm's activities of integrating, building and reconfiguring of knowledge in inter-firm collaboration. Further, the potential for knowledge transformation exists when learning actors are placed in new situations or are presented with new ideas. Companies' collaboration in NPD networks brings together firms with different technologies, markets and experiences. Doz (1996) emphasises the importance of the 'transforming' of different types of knowledge in order to succeed in collaborated networks. In studying knowledge management, Marshall and Brady (2001) claim that knowledge integration may codify extant knowledge into a new knowledge development process, which leads to finding better solutions for similar problems in future developments.

Another related theory is the concept of 'cross-fertilisation'. In the literature, the 'cross-fertilisation' effect depicts the fusion of different knowledge and technological capabilities in innovation networks (Inkpen 1996; Pyka 2002; Singh 2008). In this sense, a single type of knowledge cannot be explained in isolation but should be understood in a broader framework. For example, improvements in one type of knowledge may inspire totally different type of knowledge or even create totally new knowledge. Behind these proves is mutual stimulation and pressing ahead for improvement, the so called 'cross-fertilisation' effect of different type of knowledge (Mokyr 1990; Kodama 1986; Pyka 2002). Quinn (1992) calls this 'cross-functional serendipity' and claims the interaction between skilled people in different functional activities often develops unexpected new insights or solution.

The above contextual views are differentiated from a static perspective of the transfer of knowledge as discussed earlier. These views provide supports to the phenomenon of 'cross-transformation' of knowledge suggest by the present study. Nevertheless, the phenomenon of knowledge cross-transformation is still an under-researched area with only a few exceptions. For example, Carlile and Rebentisch (2003) discuss the 'knowledge transformation cycle' to examine how knowledge is integrated in complex technology and product innovation settings. The knowledge transformation cycle consists of storage, retrieval and transformation, and it goes as a cycle, without end. The concept of the knowledge transformation cycle echoes the concept of the reciprocal process of knowledge exchange which has been termed ''reciprocal knowledge transfer' by Bresman, Birkinshaw and Nobel (1999). Both theories emphasise that knowledge may be exchanged in either or both of the following directions: (1) from the acquiring firm to the acquired firm; and (2) from the acquired firm to the acquiring firm. These studies provide some, yet insufficient, understanding for the phenomena of cross-transformation, especially in the 'cross' element which is a unique attribute in network collaboration. Further research on the topic of 'cross-transformation' is recommended.

Antecedents: Dialogue, Articulation, Pollination and Experience

In exploring how firms manage the proposed NPD network learning process, the three case studies suggest that companies mainly engage in four major activities: dialogue, articulation, pollination and experience. Results of three case studies also indicate that companies apply dialogue, articulation and experience for knowledge transfer and engage in pollination, articulation and experience for knowledge cross-transformation. In testing these propositions, results of structural equation modelling tests indicate that dialogue, articulation and experience have significant impacts on knowledge transfer that pollination and articulation have positive impacts on knowledge cross-transformation. However, results of large scale survey research suggest that experience does not associate with knowledge cross-transformation. Details are discussed below.

Dialogue on Knowledge Transfer

Empirical evidence of the three case studies suggests that in working with NPD network alliances, companies often used the methods such as talking, discussion or meetings for knowledge transfer. The present study adopts the term 'dialogue' to depict this phenomenon (Issacs 1993; Beeby and Booth 2000; Nonaka and Toyama 2005). The importance of dialogue was highlighted in all three cases. For example, one informant from the case of e-Business stressed: *'Keep talking…I mean we learn from talking with our customers for what they want and our customers talk to us for what we can do for them…*'. Another informant from the case of Tourism highlighted: '*…we managed some three-way discussions in which we involved customer and customer's customers to try to understand they key issue that they had…*'. An informant from the case of Oil reiterated: '*…we presented that in a meeting or send them our requirements to this…we involved and learn with our supplier right from the beginning…*' Multiple-case study results suggest that companies engage in dialogue allowing them to gain knowledge previously unavailable to them and that this process is important to facilitate knowledge transfer in collaborative NPD projects.

Results of large scale survey research support this proposition. Data from survey research indicate that in working with NPD network alliances, companies were involved in a high degree of dialogue engagement on all the items of this factor with mean values 4.99-5.65 out of 7 points. Furthermore, results of the structural equation modeling test indicates that dialogue positively impacts on the transfer of knowledge with $\beta = 0.27$ at $p < 0.05$ level.

In studying organisational learning and inter-organisational learning, 'dialogue' is an important topic. Issacs (1993) argues that dialogue is central to the notion of organisational learning on the grounds that it 'holds promise for the promotion of collective thinking and communication' (p.28). Beeby and Booth (2000) claim that the theory and practice of 'dialogue' is currently the most powerful available means to facilitate inter-firm learning. Dialogue occurs when people speak with and listen to one another in mutuality, reciprocity and co-inquiry, thus changing their shared reality (Schein 1993; Issacs 1993; Romme and Dillen 1997). Indeed, dialogue is the means by which firms access, collect, and share what they know.

Companies today face a degree of complexity that requires intelligence beyond that of any individual. To solve problems in complex systems, tapping the collective intelligence of groups of knowledgeable people is required, and to engage in dialogue is therefore essential (Rindfleisch and Moorman; Hellstrom et al. 2002; Johnston and Paladino 2007). This phenomenon is especially prominent in the case of NPD collaboration which is evidenced by current research. By encouraging companies to communicate and think together, empirical evidence indicates that 'dialogue' plays a key role in fostering the transfer of knowledge. Nevertheless, empirical evidence also suggests that effective dialogue is critical but not sufficient for knowledge transfer. As highlighted by one informant in the case of e-Business: *"In my opinion, most people are pretty bad in explaining things; also there is a huge difference between speaking and communicating. It can be an issue…"* Results from the three case studies suggest that, in addition to engaging in dialogue, companies also engage in 'articulation' for knowledge transfer.

Articulation on Knowledge Transfer

In many cases, 'dialogue' promotes knowledge transfer in network collaboration as discussed earlier; yet, as uncovered by the current research, dialogue alone is insufficient for knowledge transfer. Empirical evidence from the three case studies indicates that tacit knowledge (un-codified, difficult to share knowledge) is a challenge in knowledge transfer. As an informant in the case of e-Business described his frustration *"…the language they used was simply different from the language we used. And it is very difficult to communicate with them. Clients found difficulty understanding us, and we found difficulty understanding client. We didn't know what they really wanted. This understanding issue could be a big mass…"* As discussed earlier, the issue of tacit knowledge was intensively discussed by the group of researchers with interpretive views. Results of case studies indicate that companies often engaged in activities, such as, talking to their product development network partners experienced personnel, learning by doing via trial and error, educating product development personnel with knowledge from product development network partners or frequently studied the documents of allied firms. The present study terms this phenomenon of companies' engagement in 'understanding' each other as turning 'articulation' (Inkpen 1996; Holmqvist 1999; Von Hippel and Katz 2002). Companies' engagement of 'articulation' helps to turn tacit knowledge explicit in the process of knowledge transfer.

In examining the theme of 'articulation' and its impacts on knowledge transfer, survey research results show the high extent of a company's articulation engagement on all the items of this factor with mean values 4.08-5.36 out of 7 points. Results of structural equation modelling indicate that 'articulation' positively impact on knowledge transfer with $\beta=0.44$ at $p<0.01$ level. The results also indicate that the association of articulation on knowledge transfer is the strongest, among three the antecedents (dialogue: $\beta=0.27$, articulation: $\beta=0.44$, and experience: $\beta=0.23$). .

Studies in the related literature were also found to be supportive of this important theme found in the NPD network learning process. In the literature, 'articulation' has been studied by many scholars, especially in studies on tacit versus explicit

knowledge. For example, Polanyi's most quoted line is probably 'we know more than we can tell' (Polanyi 1966, p.4). Polanyi believes that knowledge always has an inarticulate component. He terms this component the tacit dimension. This unspeakable knowing is what Polanyi deems 'tacit' as distinct from 'explicit'. In studying the transfer between tacit and explicit knowledge, the SECI process (Nonaka 1994) emphasises the importance of 'externalisation' that facilitates the process of turning a firm's tacit into inter-firm's explicit knowledge. In studying the knowledge management model, Hedlund (1994) highlights that 'articulation' is essential in facilitating the transfer of knowledge in the model. In studying transferring knowledge in open innovation, von Hippel and Katz (2001) argue that the higher the heterogeneity of knowledge is, the higher investment requires companies to solve the problem of tacit knowledge. They claim that this investment mainly lies in the effort of 'articulation'. In studying firm-level alliance learning process, Kale and Singh (2007) claim that, in alliance learning, knowledge and know-how is often 'tacit', and companies learn more if they can make efforts in articulation to turn tacit knowledge into explicit in the knowledge transferring process.

A number of researchers have argued and shown that the knowledge required by product development problem solvers is indeed often costly and sometimes difficult to transfer, for which companies' engagement in articulation is of importance (Teece 1998; Brown and Duguid 2001; von Hippel and Katz 2002, Nonaka and Toyama 2005). Indeed, tacit knowledge is difficult to understand and share, and often a challenge in knowledge transfer in NPD network collaboration. This reasoning results in the view that articulation is essential in facilitating the transfer of knowledge (Hedlund 1994; Nonaka 1994).

Experience on the Transfer

Data from the three case studies suggest that companies apply 'experience' in knowledge transfer. In current research, 'experience' refers to a company's expertise or experience with its network alliance's technology/process know-how. For example, for better knowledge transfer, a high level of expertise with the network

partners' know-how has been highlighted by an informant from the case of Tourism: *'…when our customer wanted things specifically for their business, I understand better and always provide good solution for them. It was our past experience in the industry that helped us…'* In the case of e-Business, 'rich experience and expertise' has been viewed as important in transferring know-how: '*…you can't just give them a book and tell them take the book and build the circus yourself…the area we are working is not like that. It's our hand- on know-how, the experience that we cumulated over those years by serving many different clients…'*

Empirical evidence from the large scale survey indicates positive results in assessing companies' involvement in 'experience' and the association between companies' engagement of 'experience' and knowledge transfer. Results of the survey research show the high degree of companies' engagement in 'experience' on all items in this factor with high mean values of 4.75-5.02 out of 7 points. Results of the structural equation modeling indicate on a positive association between experience and knowledge transfer with $\beta = 0.23$, $p<0.01$.

In the literature, knowledge transfer requires experience is repeatedly highlighted (Levitt and March 1988, Powell 1998; Michael and Palandjian 2004). In studying organisational learning, Levitt and March (1988) claim that learning requires experience and experience facilitates knowledge transfer. Pyka (2002) argues that without a common knowledge base and shared experience, a simple know-how transfer is not possible. In the process of knowledge transfer between strategic alliance partners, Simonin (1999) highlights the critical role played by experience on knowledge transfer and further claims that through the process, companies are able to develop collaborative know-how to obtain further collaborative benefits.

Knowledge transfer has been viewed as a process through which one company is affected by the experience of another company (Argote and Ingram 2000; Hasty, Massey and Brown 2006). Knowledge transfer occurs by moving a sender's understanding to a receiver with the transfer manifested through changes in understanding of the recipient. Argote and Ingram (2000) pinpoint that experience is

a key to this 'change of understanding' in the process of knowledge transfer. Indeed, not only is the transfer of knowledge more likely to succeed when it is related and similar to what an firm has undertaken before (experience), but that experience should lead to a greater capacity (know-how) to implement future expansions successfully (Simonin 1997). In one of the interviews in the tourism industry, the key informant from a spoke-company was asked what the key successful factor of the co-work projects with the hub-company was, and answered: *"…they introduced the product at the world they worked before* (the experience*). So, I think one of the key success factors was that their expertise on hotel business that helps them to understand what we are talking about faster…"* Indeed, 'experience' does count!

Pollination on the Cross-Transformation

Results from the three case studies suggest that in facilitating cross-transformation of knowledge, it is critical that companies engaged in collecting and integrating different knowledge from different types network partners. The present study terms this phenomenon 'pollination' which highlighting the fusion effects of different types of knowledge in product development networks. Pollination is a subtle phenomenon in fostering cross-transformation of knowledge in product development network learning. As described by the supplier of the hub company (CT4) in the case of Tourism: *"…I (CT4's supplier) think they* (CT4*) have the majority of credit* (for product development*). They went away with the feedback we gave them and collaborating some elements from their customers into it to get it work, and then came back and asked us to produce the product. This is good for both companies. Because they wanted to create a solution that was the best for them. It helped us to get new ideas. And we also applied this advanced technology with our other customers…"* In working with product development allies, empirical evidence from the three case studies also indicates that companies engage in pollination to provide an important effect in cultivating companies' knowledge cross-transformation.

In examining companies' engagement in 'pollination in NPD network collaboration, results of the large scale survey indicate a company's high extent of all items in this antecedent with mean values: 4.55-4.56 out of 7 points. Further, in testing the

impacts of pollination on knowledge cross-transformation, structural equation modeling testing results indicate that pollination is positively associated with knowledge cross-transformation with $\beta = 0.24$ at $p < 0.01$ level.

Related theories to the theme of 'pollination' are found limited in the literature with a few exceptions. For example, Marsh and Stock (2006) propose a theory of 'integrative practice' that contributes to dynamic capability in new product development. Marsh and Stock's integrative practice stresses the integration of knowledge developed in prior new product development projects. Marsh and Stock's concept on 'integration of knowledge' may be the closest theory to the emergent theme of 'pollination' in the present study. Pyka (2002) uses the term 'cross-fertilisation effects' to describe the fusion of different technological capabilities in innovation networks. Singh (2008) adopts the term 'cross-fertilisation' to stress the integrated knowledge across different locations.

NPD networks offer the possibility to build on different specific knowledge bases. With the fusion of different types of knowledge, the exploration of new knowledge and new opportunity become possible. This creation of new or advanced knowledge, as found in current research, constitutes the synergetic or surplus effect of NPD network collaboration. In studying NPD network collaboration, companies' engagement in pollination, especially on its association with knowledge cross-transformation, is still an under-researched area. Further research is recommended.

Articulation on the Cross-Transformation

As discussed earlier, in the context of new product development, knowledge is often 'tacit' in nature (von Hippel et al. 2002). Data of the three case studies indicate that tacit knowledge can be an issue in the process of knowledge cross-transformation as one of key informants in the case of Oil described: "*…yes, if we all* (the hub company and its network alliances) get together… *we thought it might be valuable over the year, when we finally had our meetings, we said 'let's get all the people who are interesting in 'size making', together and talk about what to do next'. So, the*

experts were hungry coming to this meeting. BUT, big problem came. We didn't 'read' each other…At the end, everybody was just wasting time…"

Results of the three case studies also suggest that companies engage in 'articulation' for knowledge cross-transformation. As described by one of the informants from the e-Business case, when asked how the company works with its network allies: "…*we work together, for example, we often have conference calls with all three parties (suppler, customer, and customer's customer) to get together. We study complete set of plans, have a discussion, or have an electronic presentation while all three parties are all involved…The purpose is to align everyone to the overall project, to make sure everyone is aware of the experience of the product, and to align end customer to have some input for what they would like to see next…and we encourage our suppliers to do the same thing, thus we all become better for our new products…".* Empirical evidence from the three case studies suggests that companies engage in articulation by working together with network allies to have 'common understanding' or 'shared code' in which the activities of 'articulation are carried out (Dougherty 1992; Grant 1996; Cohendet and Llerena 2007; McLaughlin 2008).

In testing the association between articulation and knowledge cross-transformation, results of the survey research support the proposition that companies engage in articulation in their cross-transformation of advanced knowledge with significant association between articulation and knowledge cross-transformation at $\beta = 0.37$, $p = 0.05$ level. The importance of companies' engagement in articulation for knowledge cross-transformation is further reinforced by the mediating effect assessment in current research. Results of the SEM test indicate a partial mediation effect of the transfer of knowledge on the cross-transformation of knowledge. That is, companies' engagement of articulation is not only directly associated with knowledge transfer but also directly impacts on knowledge cross-transformation. This result is different from the mediating effect of assessment results on the engagements of dialogue and experience, in which both cases are fully mediated by the effect of the transfer of knowledge on the cross-transformation of knowledge.

That is, companies' engagements of dialogue and experience do not directly associate with knowledge cross-transformation.

In the literature, the importance of 'articulation' to facilitate 'common understanding' or 'shared code' has been highlighted in the studies of 'co-evolution' in working with network alliances and a firm's capability to exchange and combine knowledge. For example, in studying complex co-evolution, Cohendet and Llerena (2007) highlight the importance of shared codes that accommodate the common understanding among learning actors in the knowledge creating community. They defined 'shared code' as: 'the externalities were internalised through the process of controlled communication that lies behind the building of a common base of knowledge to make the innovation understandable and viable' (Cohendet and Llerena 2007, p.59). This process of externalities being internalised depicts the act of of articulation in current research. In studying 136 technology companies, Collins and Smith (2006) found that shared codes and common language play a key role in knowledge exchange and combination in developing new products. Collins and his colleague claim that, in NPD network collaboration, 'common understanding' or 'shared code' facilitates a companiy's knowledge cross-transformation; companies hence co-evolve.

Building on the empirical evidence from current research it is indicated that tacit knowledge is not only difficult to share but also not easy to integrate and transform into advanced or new knowledge (Grant 1996; Beeby and Booth 2000). Data from the three case studies have reflected that the lack of the 'common understanding' or 'shared code' creates difficulties to the process of knowledge cross-transformation among different network alliances, in which companies' engagement of articulation is highlighted. The topic of 'common understanding' or 'shared code' for the knowledge cross-transformation is an important area, and requires further investigation. Further research in this regard is recommended.

Experience on the Cross-Transformation

Results of the three case studies suggest that experience is important to companies' knowledge cross-transformation activities. Data of the large scale survey research, however, show an insignificant association between companies' engagement in experience and knowledge cross-transformation. Further, the results of mediating effect assessment indicate a full mediation effect of knowledge transfer on knowledge cross-transformation. That is, experience positively impacts on the transfer of knowledge; yet it is not directly associated with a company's cross-transformation activities. In the literature, a company's experience has been viewed as being important to knowledge exchange in network collaboration as discussed earlier (Day 1994; Pyka 2002; Simonin 1999; Powell 1998). However, contradictory views have argued that 'experience' has a negative effect and is not always an automatic company positive asset, especially in the context of product innovation (Moorman and Miner 1997; Hedberg 1981; Levinthal and March 1993; Sinkula 2002).

In studying business network collaboration, a company's experience, especially with its network partners' technology and process know-how, has been somewhat assumed as being unconditionally helpful to the process of knowledge and know-how exchange (Day 1994; Montoya-Weiss and Calatone 1994; Zirger and Maidique 1990; Simonin 1999). Powell (1998) claims that a company's prior knowledge facilitates the acquisition of more knowledge, in that experience is required for a firm's product development network collaboration. Pyka (2002) argues that without a common knowledge base and shared experience, a simple know-how exchange is not possible. That said, companies need experience and prior knowledge to benefit from new knowledge presented by their uncertain environments (Ingram 2002).

Nevertheless, contradictory views have also been presented and studied. For example, Weick (1993) has noted that experience played a role in successful and unsuccessful improvisation. Moorman and Miner (1997) provide some evidence that experience is not an unconditionally positive asset. They suggest that companies pay attention not only to the application of appropriate level of experience but also the

subtle dispersion of 'unhelpful' experience. Michael et al. (2004) claim that organisational experience is likely to have a negative effect on product innovation performance, displaying what has been called 'core rigidity' (Leonard-Barton 1992) or a 'competency trap' (Levitt and March 1988). Scholars who studied 'unlearning' highlight the negative effect of a firm's experience on new learning (Huber 1991; Nystrom and Starbuck 1984; Day 1994). Unlearning stems from a belief that a firm's past experience inhibits new knowledge creation (Hedberg 1981) and emphasises that a company should discard its past experience in order to 'clean up' a space for new knowledge to kick in (Hedberg 1981; Levinthal and March 1993; Sinkula 2002).

Building on empirical evidence and extant research, it is suggested that, in product development network collaboration, companies with shared experience from their networked alliances, make the transfer of knowledge easier. In this case, a firm's experience does offer learning actors help other learning actors in accessing, assimilating and dissimilating knowledge. Nevertheless, once knowledge and know-how is transferred, experience plays a less important role in advanced knowledge creation. Instead, companies may need to apply the technique of 'unlearning' in the process of advanced / new knowledge creation and knowledge cross-transformation. What they newly learn is hence not jaded by the experience. In more experienced organisations, it is unlearning that makes way for new mental maps that transform into new/advanced knowledge (Sinkula 2002; Akgun et al. 2006). Does experience matter? It is a question which begets many intellectual arguments. Current research, from the NPD network learning perspective, hopes to shed some light to this arguable issue.

Uncertainty Reduction and Speed-to-Market

Uncertainty reduction and speed-to-market have been viewed as two major objectives of product development process activity, and the notion of knowledge and information closely associated with reducing uncertainty and NPD cycle time is well accepted (Souder and Moenaert 1992; Griffin 1997; Lynn et al. 1999; Parry et al.

2009; Langerak, Hultink and Griffin 2008). Current research studies show that the proposed NPD network learning process (namely knowledge transfer and knowledge cross-transformation) is associated with uncertainty reduction and with speed-to-market. Details are discussed below.

NPD Network Learning Process and Uncertainty Reduction

Empirical evidence from the three case studies indicates that knowledge transfer alone does not impact on uncertainty reduction in NPD network collaboration. It is the cross-transformation of knowledge in network collaboration that leads to uncertainty reduction in product development. When an informant in a tourism case study was asked about the experience of network alliances learning and uncertainty reduction in developing new products, she emphasised it was not only knowledge sharing, but idea integration that helped: *'…without working with our network partners, we would still uncertain for many things. Will the customer accept it? Do we have enough know-how? Our idea would just not possible to be developed into a product. It is not from only one partner, It's not only you share the know-how; it is really the cooperation with all our partners and their business partners…without integrating their ideas, our dream would never come true…'.*

In examining the association between knowledge cross-transformation and uncertainty reduction, data from the structural equation modelling test support the hypothesis that knowledge cross-transformation positively associates with uncertainty reduction with $\beta = 0.44$ in customer uncertainty reduction, $\beta = 0.69$ in technology uncertainty reduction, $\beta = 0.50$ in competition uncertainty reduction, and $\beta = 0.56$ in customer uncertainty reduction, all at $p < 0.01$ level. In further understanding the association among knowledge transfer, knowledge cross-transformation and uncertainty reduction, results of the mediating effect assessment suggest a full mediating effect of knowledge cross-transformation on uncertainty reduction. That is, knowledge transfer does not directly impacts on uncertainty reduction, but knowledge cross-transformation does directly associate with uncertainty reduction.

The notion of uncertainty reduction and the knowledge exchange that is closely associated with it can be viewed as the main objective of product development process activity (Souder and Moenaert 1992; Lynn et al. 1996; Souder et al. 1998; Tatikonda et al. 2001; Beckman et al. 2004; MacCormack et al. 2003; Liu and Hart 2006). Uncertainty occurs due to a critical lack of knowledge (Rosenberg 1988; Lynn et al. 1996) and can be managed more effectively if specific practices of knowledge exploitation and creation are carried out (Dougherty 1992; Chen, Reilly Lynn 2005; Lee and Veloso 2008). This reasoning resulted in the view that new product development is essentially an exercise (or series of exercises) in uncertainty reduction aimed at closing knowledge gaps. In closing these gaps, different kinds of knowledge are required as uncertainties may arise from different sources during product development.

In studying uncertainty reduction, much of the literature has claimed that business networks provide superior opportunity for uncertainty reduction due to their greater diversity of knowledge (Powell et al. 1996; Håkansson and Johanson 2001; Uzzi and Lancaster 2003). It has been claimed that the different types of knowledge transfer contribute to successful uncertainty reduction (Tatikonda and Stock 2003; Moenaert and Souder 1990). For example, Tatikonda and Stock (2003) studied product knowledge transfer in companies' supply chains and suggest that product knowledge transfer is positively associated with uncertainty reduction in product development projects. In understanding crisis events in innovation projects, Edwards (2007) highlights that companies' ability of knowledge transfer from external sources is linked to their coping with uncertainty reduction.

Nevertheless, Hirsch and Meyer (2010), in studying the assessment of cooperative relationships between firms, claim that it is the co-specialisation of knowledge that contributes to uncertainty reduction. Hirsch and Meyer's assertion of 'co-specialisation' emphasises the effect of co-evolution and resonates to the findings in current research, that is, companies attempt to mitigate uncertainty in product development by engaging in the transfer of knowledge is important but insufficient.

It is the cross-transformation that contributes to uncertainty reduction in NPD projects.

NPD Network Learning Process and Speed-to-Market

Results of both qualitative case studies and survey research also indicate that the transfer of knowledge alone does not impact on speed-to-market. It is the cross-transformation in network collaboration, not the transfer of knowledge, which leads to speed-to-market in new product development process. As the informant from the hub company in the case of e-business highlighted: *…as I mentioned earlier, our company's success is based on a rich 'fusion' culture. It is the culture to work together and to learn together. Today we may be a student to learn from our working partner; tomorrow we may turn to be a teacher to teach others what we have learnt. It is this' fusion culture' that helps us…and pushes our product development process from idea to launch quicker…'* In examining the association between knowledge cross-transformation and speed-to-market, data from the structural equation modelling test indicate knowledge cross-transformation positively impacts on speed-to-market with $\beta = 0.34$ at $p < 0.01$ level. Further, results of the mediating effect assessment test suggest that knowledge transfer does not directly associate with speed-to-market, a full mediating effect is revealed and implies that knowledge cross-transformation mediates the effect of knowledge transfer on speed-to-market.

In the literature, it has been stressed that companies today face highly competitive and dynamic environments and the associated need is to bring developed new products to market more quickly (Eisenhardt 1989; Bird, Eisenhardt and Lyman 1990; Griffin 1997; Karagozoglu et al 2004). Further, several studies stress that for executives' faster decision making, adequate cross-specialised knowledge is needed in the product development process. Much of the literature has concluded that working with allied companies helps to decrease product development cycle time and expedite the speed-to-market for a new product (Rindfleisch and Moorman 2001; Kessler and Chakrabarti 1996; Eisenhardt and Tabrizi 1995; Crawford 1992; Mabert et al. 1992; Gold 1987).

The association between knowledge and speed-to-market in new product development has drawn the research interest of many scholars. Much of the literature highlights the importance of knowledge sharing and knowledge transfer to speed-to-market in NPD projects. For example, Akgun et al. (2005) studied knowledge networks in NPD projects and its link to the speed-to-market and concludes that knowledge sharing is of importance to speed-to-market. Johnson, Piccolotto and Filippini (2009) examine how knowledge competence and time performance are related in driving successful NPD, and found knowledge transfer is positively associated with product developing speed. Singer and Helferich (2008) analyse the flow of knowledge between support groups and their customers, and emphasis its impacts on speed to market in R&D. Lynch and O'Toole (2006) investigate knowledge sharing with external alliance and speed to market in NPD process. They stress that knowledge sharing positively influences speed to market in working with external alliances. This group of researchers conclude that knowledge sharing or knowledge transfer is important and positively impacts on speed to market in NPD.

Interestingly, in studying the semiconductor industry in Japan, South Korea and the United States, Appleyard, Brown and Sattler (2006) have found contradictory results. Using a survey of engineers in semiconductor companies located in three countries, Appleyard et al. (2006) examine how a company's knowledge access and sharing impacts on technical problem-solving speed and found no evidence linking the association of the knowledge access/sharing and problem-solving speed. Appleyeard et al (2006) work supports findings of current research that knowledge transfer does not impact on speed-to-market. Further, while Appleyard et al. (2006) conclude that the reason for companies seeking knowledge transfer from external sources may have nothing to do with speed in product development, current research suggests that knowledge transfer is still important yet insufficient in increasing product developing speed. The present study suggests that it is the cross-transformation of knowledge in network collaboration, not the transfer of knowledge alone, which accelerates product developing speed.

Finally, in the literature, building knowledge competence is a strategy that management can proactively utilise to cope with uncertainty reduction, which has been argued to moderate the speed-to-market in NPD (Kessler and Bierly 2002; Chen, Reilly and Lynn 2005; Johnson, Piccolotto and Fillippini 2009). The association between uncertainty reduction and speed-to-market is an important topic in studying NPD. A further study on the moderation of uncertainty reduction on speed-to-market would deepen the understanding in this regard.

9.3 CONTRIBUTION

By focusing on learning in business networks, the present study complements the existing research streams in NPD network learning and contributes to available knowledge by proposing a theoretical model in its process. The contribution of current research is driven from different aspects both in theory and in practice. First, in the context of NPD, the present study contributes to the literature of learning by investigating business networks, an under-researched area. The concept of knowledge cross-transformation is revealed in current research as an important attribute in studying business network collaboration in NPD. The 'cross' effect of knowledge transformation accommodates a company's knowledge creation and advancement in NPD network collaboration.

In recent years, many studies have concluded that new product development is the outcome of collaboration in business networks (e.g. Powell et al. 1996; Rindfleisch and Moorman 2001; Andersson and Dahlqvist 2001; Hellstrom and Malmquist 2000). Much of the relevant research has helped to the understanding on dyadic relationships, but not on business networks which involve two or more connected business relationships either directly (e.g. supplier and customer) or indirectly (e.g. supplier and customer's customer). The study of dyadic relationships is no longer sufficient to help companies cope with challenges in NPD collaboration. The concept of knowledge cross-transformation suggested in the present study contributes to further understanding in the area of NPD network collaboration and paves further paths for NPD network study.

The present study also contributes to the extant literature not only by providing empirical support to many existing theories and key assumptions in extant research, but also by clarifying and reconciling contradictory views in the existing literature. Building on empirical evidence by a mixed method approach, current research also contributes to the literature by providing support to many existing theories and key assumptions in the literature. For example, the present study echoes the theories of 'dialogue' and 'articulation' in the literature and emphasises their importance to inter-firm learning and knowledge exchange. Current research resonates to the proposition in the literature that learning and knowledge exchange positively impacts on uncertainty reduction and speed-to-market in developing products. In the context of NPD, current research also supports the assertion from extant research that the collection and integration of different types of knowledge are important in business network collaboration, in which is termed 'pollination' in current research.

Further, through a mixed-methods approach, current research clarifies and reconciles contradictory views of the associations between the proposed NPD network learning process and its antecedents - dialogue, articulation, pollination and experience, and also augments the current understanding on how this process impacts on two NPD performance measures - uncertainty reduction and speed-to-market. By broadening the understanding of how firms learn about NPD in their business networks, current research deepens the insights of how to increase the value of product innovation network collaboration. For example, in studying the theory of knowledge transfer, the information-processing approach has been the dominant view for many years. Yet, researchers with an interpretive view disagree with the 'pure' information-processing approach and recognise how different domains naturally generate interpretive differences. The present study, building on the empirical evidence, reconciles these two different views by claiming that knowledge transfer has its roots in the information-processing approach in which accessing, assimilating and disseminating are highlighted. Nevertheless, companies are found engaging in activities that are emphasised by researchers with interpretive views to better

implement the act of 'knowledge transfer', such as dialogue, articulation, sharing meaning and common understanding.

In studying experience, scholars have different views on its association with knowledge exchange. One group of researchers emphasises that learning requires experience, and experience facilitates knowledge exchange. Another group of researchers claims that experience may have negative effects on learning from where the theory of 'unlearning' stems. The present study suggests that whether experience impacts on learning or not depends on different stages of the learning process. Current research found that in NPD network earning process, experience is important at the stage of knowledge transfer, yet it may not be significant at the stage of knowledge cross-transformation.

Further, much of the literature has claimed that knowledge transfer contributes to successful uncertainty reduction and speed-to-market for NPD projects. In deepening understanding in this regard, the present study claims that companies that attempt to mitigate uncertainty and expedite speed-to-market in product development, engage in knowledge transfer that is important but insufficient. It is knowledge cross-transformation that contributes to uncertainty reduction and speed-to-market in NPD projects.

In sum, from a knowledge-based view, the present study proposes a theoretical model that depicts how NPD network learning was implemented and worked in successful NPD projects. The model contributes to theory with a more comprehensive picture in NPD network learning by not only uncovering companies' learning process, but also linking this process with its antecedents and with its results.

The study also contributes to the methodological literature. By using the structural exploratory mixed-methods approach to conduct the research, the present study broadens the scope of doing research in the field of new product development network learning. Two complementary research approaches are envisaged in this

study to explore empirical phenomena and to examine the proposed constructs. The mixed-methods approach has been regarded as feasible as well as useful in searching for a multi-perspective and inter-connected view of a complex research topic. Despite the availability of mixed-methods-related books, chapters, and journal articles (e.g. Creswell 2003; Hanson et al. 2005), virtually nothing has been written about mixed-methods research designs in new product development, specifically, in new product development network learning. The exploratory experience together with a step by step process in a sequential quanti-quali design is recorded and reported. Further, doing research in business networks (especially in data collection) is not an easy task due to its 'network' nature (Håkansson and Johnson 2001). The snow-ball approach with a hub-and-spoke structure suggested in the study provides one possible solution.

Finally current research contributes to managerial practice in its process and implementation. The importance of business network learning to NPD success has often been stressed (Powell et al. 1996; Kodama 2006; Macher and Mowery 2009). However, business network learning has been found to be a challenge and many have failed (Hamel 1999; Håkansson and Johnson 2001; Beamish and Berdrow 2003). For practitioners, the present study contributes to a process on how knowledge and capabilities are developed, managed, and deployed when coping with challenges in NPD, and facilitates an understanding of how this process impacts on uncertainty reduction and speed-to-market. To managers and to product development teams, the study provides empirical guidance of how to learn effectively in their efforts to build up successful and valuable product development networks.

To sum up, in today's economy, bilateral fit (i.e. inter-firm dyadic relationships) is no longer sufficient. Product developers also look into the fit in the overall alliance in its business networks (Powell et al. 1996). Building the right relationships with the right partners is a challenge for many companies (Duysters et al 2003). However, in NPD network collaboration, having right relationships with right partners does not guarantee company's return on this investment until impact occurs. Learning effectively in NPD networks has become a key managerial issue that

challenges academics' and practioners' minds, given the awareness that firm's future existence depends significantly on their capability to generate a continuous stream of new products (Marsh and Stock 2003; Carlile 2004; Marshall and Brady 2001). A basic question that challenges researchers' and practioners' minds is how a company gets into its fit in its product development networks collaboration that help to sustain its competitive advantage. To this end, the present study wishes to shed some light to provide some answers to the question. Finally, to understand theory is not a challenge, the challenge lies in the managerial practice and implementation of the theories. Managers who make efforts to well implement the NPD network learning process in knowledge transfer and knowledge cross-transformation will be rewarded.

9.4 MANAGERTIAL IMPLICATIONS

The implications for managerial practices lie in different aspect. First, new product development is increasingly being viewed as a dynamic interplay between or among two or more actors. The basic tenet of this relationship is that linkages with other actors help firms to create value by working and learning together. However, business network learning often does not achieve its original goals and many fail (Håkansson and Johanson 2001). The cost of failure can be tremendous. One of the key issues may lie in that many companies only pay attention to knowledge transfer in their NPD network collaboration. The present study, building on empirical evidence, urges product developers and managers when collaborating with business network partners, to not stop at the transfer of knowledge, but work further with allied companies for the cross-transformation of advanced knowledge. In network collaboration, knowledge transfer is important and well accepted as a driving factor in working with external alliances. Nevertheless, knowledge transfer is simply not enough as suggested by current research. Indeed, the value of NPD network collaboration lies, not in knowledge transfer alone, but in a cross-effect of the knowledge transformation.

Further, for those managers who aim at optimising NPD through working with alliances, the message is that better managing knowledge cross-transformation may

lead to better results in uncertainty reduction and speed-to-market. To cope with rapid changing and uncertainty in product innovation, firms' ability to create, transfer, assemble, integrate and exploit knowledge assets is essential. These phenomena have been observed and discussed in the literature (Souder and Moenaert 1992; Souder et al. 1998; Daft and Weick 1984; Slater and Narver 1995; Cohen and Levinthal 1990; March 1991). In the literature, it has been claimed that knowledge transfer contributes to successful uncertainty reduction and speed-to-market (Tatikonda and Stock 2003; Moenaert and Souder 1990). However, as mentioned earlier, managers merely indulge in knowledge transfer is by itself important but may not be sufficient. In working with business network alliances, an important message to managers is: knowledge cross-transformation is an important driving factor to better NPD performance.

Managers are reminded of the value of dialogue, articulation and experience in carrying out knowledge transfer and the importance of pollination and articulation in applying knowledge cross-transformation. Nevertheless, it is not a challenge for manager to understand the theory of business network learning; the challenge comes from the implementation – it lies in well and appropriate engagements in dialogue, articulation, pollination and experience. As indicated by the results of survey research in current research, companies' engagement in articulation has the most influence on knowledge transfer among three antecedents. Managers may need to ensure their engagement in 'articulation' is well implemented. In NPD network learning, knowledge cross-transformation is important. It is recommended that managers pay attention to the collection and integration of different types of knowledge and know-how, in which the engagement of 'pollination' is highlighted. Managers are also advised to be cautious in bringing experience in knowledge cross-transformation. The empirical evidence of the present study indicates there is no association between experience and knowledge cross-transformation. The researcher believes that companies making effort to work with business network partners will be well rewarded.

The results suggest that experienced companies should be cautious. In collaborating with network allies for product innovation, there is no guarantee that firms perform well in reducing uncertainty and speed-to-market as they engage in more past experience. Product innovators may need to work with network alliances in a flexible manner and allow changes as the project evolves to facilitate new knowledge creation. However, managers should also be cautious when promoting 'unlearning' in which past experience is discarded. Without careful and considerable evaluation, change in beliefs and routines may cause information/knowledge loss. These results imply that managers and marketers may need to address not only the ongoing knowledge gathering processes for product innovation and development, but look deeply into the question of companies' experience if they are to harvest the full value of knowledge transfer and knowledge cross-transformation through business network collaboration. Finally, managers, who aim at optimising NPD through working with network alliances, are urged to consider building the proposed NPD network learning model and its related implementation process uncovered by the present study into their company philosophy, corporate culture and employee training programs.

9.5 CONCLUSION

New product development is not only a vital but also an essential task to any company. It is vital because it relates to a firm's short- and long-term growth and survival. It is essential because behind any product development failure, a substantial amount of capital is lost and cash flow may be detrimentally affected. The value of current research is central to this vital and essential need. In developing new products, companies have substantially increased their use of network alliances in recent years (Gulati, Nohria and Zaheer 2000; Das and Teng 2000; Doz and Hamel 1998; Dyer and Singh 1998; Gulai 1995). There is much evidence that firms new product development is a result of inter-firm learning in collaborative networks (Powell et al. 1996; Johnston et al. 2007; Ford et al. 2002).

Despite the importance of NPD network learning, the use of networks is not a guarantor of NPD success (Håkansson and Johnson 2001). Network learning in NPD

often does not achieve its original goals, and many NPD co-projects fail. The present study argues that if we do not know 'how NPD network learning works', improvement is difficult. The thesis departs from the premise that if we assume that product development success depends on how well a firm works and learns in business network collaboration; then understanding the mechanism of NPD network learning becomes critical. Current research uses firms and their alliances in successful NPD projects as a context and conceptualises that engaging dialogue, articulation, pollination and experience facilities the NPD network learning process of knowledge transfer and knowledge cross-transformation, aiming at uncertainty reduction and speed-to-market. Supported by empirical evidence and the extant literature, the study suggests that firms need knowledge to develop capability for problem solving in the NPD process, the transfer of knowledge is essential and that engagements in dialogue, articulation and pollination are required.

Further, in successful NPD projects, the occurrence of knowledge transfer is found necessary, yet insufficient. What is added, however, is that the application of knowledge transfer and the engagements in pollination and articulation are found essential to the cross-transformation of knowledge. To exploit and to meaningfully advance their capabilities, firms integrate existing knowledge with newly received knowledge to create advanced knowledge. It requires the creation of advanced knowledge through a cross effect in knowledge transformation in collaborative networks. In this way, successful NPD can be better expected in that it brings in diversified knowledge and through the process of the cross-transformation, superior (or advanced) capabilities are produced to better address the uncertainty and speed-to-market issues.

The present study not only resonates with several theories from the related literature, but more importantly, it also clarifies and reconciles contradictory views of the related theories and key assumptions in the extant literature. For example, the present study echoes the theories of dialogue and articulation, as well as their impacts on the learning process. In studying knowledge transfer, current research reconciles the contradictory view between the information-processing approach and

the interpretive approach. Through large sample survey research, the present study reconciles the issue of whether 'experience' matters or not in NPD network learning; and the result of no association between experience and knowledge cross-transformation echoes the theory of 'unlearning'. Further, building on empirical evidence, current research deepens the understanding on how NPD network learning process associates with uncertainty reduction and speed-to-market. While current research resonates to the literature in that learning and knowledge exchange is positively linked with uncertainty reduction and speed-to-market in NPD projects, it suggests that it is knowledge cross-transformation, not knowledge transfer that leads to uncertainty reduction and speed-to-market.

Finally more work is suggested for a better understanding of the heterogeneous pathways firms take in the cycle of learning model and why some pathways lead to visible indicators of success while others do not. Several important areas are recommended from the present study for further research. For example, further understanding on the 'cross' element of knowledge cross-transformation and on the association between pollination and knowledge cross-transformation is deemed to be important in studying NPD network collaboration. Further, for better application of articulation in different types of knowledge among different network alliances, how 'common understanding' or 'shared code' can be better managed is an important topic. Finally, to better understand the association among knowledge, uncertainty reduction and speed-to-market, future research on the topic of how companies' uncertainty reduction moderates its speed-to-market in the product development process is recommended.

A very special 'thank you' to many firms and their employees who graciously gave their valuable time and efforts to this study. The researcher sincerely hopes the results are useful to them, the study's ultimate customers. The researcher is very grateful to the Product Development and Management Association (PDMA), for funding this research project.

9.6 LIMITATIONS

This study, like any other, has some limitations that future work can address. First, it should be noted that in this study the research cases and samples for both case studies and survey research were limited in the UK only. In this era of globalisation, the global economy now reaches every corner of the world and has brought new product development into another era. The researcher believes that further research that adds the factor of internationalisation on the research topic will bring further contributions and better applicability of the research topic. In this sense, this study provides a robust base for further study.

The use of single informants has been a concern for some researchers (e.g. Phillips 1981). Although this study uses a single-informant approach in the survey research, the researcher believes that this approach is warranted for the following reasons. First, the informants were carefully selected for their unique expertise and their experience in successful product development projects (which was verified through validity checks). The approach is appropriate as suggested by Campbell (1955). Furthermore, as noted by Griffin (1993 p.120), for most new product development studies, when the team reviews the individual estimates and comes to an overall consensus on the total percent change, the estimates provided by individual informants 'are surprisingly robust – they usually fall within 5% - 10% of each other'.

Finally, in testing the impacts generated by the proposed business network learning model, this study used uncertainty reduction and speed-to-market as the performance measures in new product development. The researcher believes these are two important measures that directly relate to the effect of knowledge and inter-firm learning. Nevertheless, there are many other measures to test product development performance (Griffin and Page 1993; Hart et al. 1999; Hultink et al 2000; Sivadas et al. 2000; Cooper et al 2004; Narver et al 2004). This limitation can be addressed by future research.

9.7 FUTURE RESEARCH

While inter-firm learning is hard, business network learning is even harder. More work is needed before we fully understand the heterogeneous pathways that firms take in the cycles of learning model for more effective network collaboration and for better new product development. From the globalised networks perspective, a further study on global business network learning is recommended. The internationalisation process from a network perspective has been intensively explored in the literature (Anderson 1996; Axelsson and Johanson 1992; Coviello and Munro 1997; Lu and Beamish 2001; Zain and Ng 2006). Nevertheless, we know little about how firms learn about product development in their global NPD business network. By using this study as a base, further study from the globalisation view will add value and expand understanding of the research topic.

As mentioned earlier, further research on the cross-transformation of knowledge in business network learning is recommended. What we see across the pragmatic knowledge boundary is not just a matter of the processes of transferring more knowledge, but more importantly, the iterated processes of integrating, converting, and pollinating knowledge with network alliances, that is, the processes of cross-transformation. Companies that work with alliances often put learning as a priority objective. Cross-transformation of knowledge is an important phenomenon in business network learning. Yet, we know little about this important phenomenon in business network learning. Further study on the cross-transformation will benefit firms through better management for effective business network collaboration.

Finally, managers have concerns on the return on investment from business network collaboration. Product development performance measures may provide a scorecard to understand better business network learning effectiveness. As mentioned earlier, in addition to assessing the uncertainty reduction and speed-to-market, managers may like to evaluate the results of business network learning by other measures. Many scholars provide suggestions measuring product development performance (for example, Griffin and Page 1993; Hart et al. 1999; Hultink et al 2000; Sivadas et

al. 2000; Cooper et al 2004; Narver et al 2004). To expand the understanding of the impact of business network learning on product development and to assist managers to better evaluate business network collaboration, further research on different performance measures is recommended.