Structuring technology strategy and interfirm collaboration: Empirical study on Korean high-tech small firms in telecommunications industry

by Joohan Ryoo

Thesis submitted for the degree of Doctor of Philosophy

Interdisciplinary Institute of Management
London School of Economics and Political Science
University of London

January 2005

For my parents and wife

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Table of content

Chapter 1: Introduction

Chapter 2: Fundamental issues in strategic alliance studies

Chapter 3: Telecommunications industry, technology cooperation and high-tech small firms in South Korea

Chapter 4: Literature review on antecedents of technology sourcing decision

Chapter 5: Research framework and hypotheses

Chapter 6: Operationalisation and measurement

Chapter 7: Data collection and survey result

Chapter 8: Determinants of the technology-sourcing decision in stage one (Hypotheses testing)

Table of content

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Chapter 3: Telecommunications industry, technology cooperation and high-tech small firms in South Korea

Chapter 7: Data collection and survey result

Chapter 8: Determinants of the technology-sourcing decision in stage one (Hypotheses testing)

Chapter 9: Determinants of structuring technology alliance in stage two (Hypotheses testing)

Chapter 10. Conclusion and implication

Table of content

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Chapter 3: Telecommunications industry, technology cooperation and high-tech small firms in South Korea

Chapter 7: Data collection and survey result

Chapter 8: Determinants of the technology-sourcing decision in stage one (Hypotheses testing)

Chapter 9: Determinants of structuring technology alliance in stage two (Hypotheses testing)

Chapter 10. Conclusion and implication

Chapter 1: Introduction

1.1 Background

Over the last two decades, the world economy has been transformed. Many firms are confronted with fundamentally changed business environment as industry boundaries shift, competition intensifies, technology life cycle shortens and technological development and diffusion speed up. In this turbulent and uncertain environment, every firm needs to formulate a competitive strategy to acquire the resources that enable it to outperform competitors. Technology is one of the most important resources and technology strategy (how best to structure organisational activities to acquire and develop new and innovative technology) is thus essential for all kinds of firms to survive and expand their businesses (Ford 1988). If a firm employs an effective technology strategy and successfully develops (invents) innovative technology that cannot be easily duplicated or re-deployed by others, it will achieve a better market position and win.

How do firms create such successful technology strategies so central to their survival? This is in fact the major preoccupation of the top-level management in many firms. Management scholars have found that the decision-makers normally examine one or more of four new technology development methods as their new technology development method (Schilling & Steensma 2002; Steensma & Corley 2000; Poppo & Zenger 1998; Lamb & Spekman 1997). The first option is to concentrate the firm's own resources on a set of core competencies and develop new technology independently; the second is to merge with or acquire other firms that already possess what the firm needs; the third option is to trade or exchange the required knowledge from the spot market; the fourth option is to strategically ally with other firms to outsource activities for which the firm has neither a critical strategic need nor special capabilities. Some scholars view internal development (i.e., in-house development or mergers and acquisitions) as the 'make' option while external development (i.e., strategic alliance or market exchange) as the 'buy' option within the context of the terms of the traditional logic of 'make or buy' decisions (Lowe & Taylor 1998).

No technology sourcing option is inherently superior to any other. What matters is choosing the most appropriate one for each firm. Poor decisions lead to higher costs, misuse of resources and lost opportunities. Traditionally, most firms relied on in-house development or acquisition/outright purchases because they believed it to be the best and most prestigious new technology development method (MacKun & Macpherson 1997; Abetti 1989). However, recent researches has revealed that firms are increasingly turning to innovative external modes of technology acquisition such as joint ventures, R&D agreements and joint development (Stuart et al. 1999, Young-Ybarra & Wiersema 1999; Powell 1998; Stuart 1998; Hagedoorn 1995). This occurs most often in fast-paced and hyper-competitive industries such as electronics, software, communications, biotechnology, etc. Mounting evidence confirms that although strong in-house skills are central to the new technology development, technological collaboration is the most popular alternative technology sourcing method.

Why is technological cooperation becoming more popular as a method of new technology development? Perhaps, given intensified competition and rapid technology advancement, relying solely on the firm's own ability hinders a more rapid development of new technology (Harrigan 1988). No single firm possesses or masters all core-capabilities to fulfil customer's needs and high standards sufficiently (Hikens 2000; Muller & Herstatt 2000; Shaw & Kauser 2000; Harari 1998). Individual firms cannot afford to risk increasing costs, unmarketability and the uncertainty that surrounds complex new technology development project. Supply markets are frequently imperfect and inefficient because of transaction, negotiation and contracting costs. Acquisition or outright purchase of other firms is no longer appealing option because of the demise of the junk bond market, the legal attack on takeovers, political infighting and, above all, a high degree of inflexibility (Contractor & Lorange 1988). A strategic alliance, in contrast, enables firms to complement insufficient resources and share the cost and risk of new technology development with other firms. The effect of technology collaboration is still controversial. There is, however, little doubt that technology collaboration is becoming an essential component of firms' technology strategy, and that this trend is set to continue.

1.2 Problem definition

Together with an increasing number of interfirm alliances, the 90s were characterised by the emergence, growth and success of high-tech small firms (HTSFs) in the knowledge-intensive industries. HTSFs tend to lack the financial resources and managerial capabilities, when comparing with the large firms. Compared to the large firms, HTSFs have less experience in marketing and promotion and lack the formalised strategic planning systems that allow them to fully capitalise in timely fashion (Miles, et al. 1999). However, many small firms in high-tech industries have achieved remarkable success. This applies both to technological innovation and the successful application of its results; small firms have frequently outstripped large firms in the same industry area (Lee, et al. 1999). What is their secret? They are, it appears, frequently first to commercialise and exploit new technology and are more innovative than large firms given their limited resources (Oughton & Whittam 1997). Their technological achievement is possible due to their flexibility, responsiveness to technological change and innovative ideas and their relentless entrepreneurship. The pioneering role of HTSFs in research and development seems likely to continue for many years to come.

Multiple studies have investigated the competitive strategies of successful HTSFs and how they develop and absorb new technology. Leading scholars conclude that one of the key to their success is strategic technology alliance by which HTSFs overcome their deficiencies by accessing their partner's complementary capabilities. They argue that collaboration, such as technology partnerships, allows HTSFs to carry out state-of-the-art research in order to establish their own market niche; those that manage to do this successfully come to be regarded as a window on technology by large firms (Powell, et al. 1996; Pisano 1990). By forming vertical and horizontal external linkages with other firms and institutes, technology alliance enables pooling of resources, and sharing of facilities, equipment and personnel (Lee, et al. 1999; Brush & Chaganti 1996). An increasing number of up-and-coming HTSFs in the US, Sweden, Japan and the UK are eyeing strategic alliance as they build more and tighter relationships with other companies. This has helped them sustain their business through greater external economies of scale, enhanced market position and by allowing them to exploit new technological opportunities (Rosenfeld 1996; D'Souza & McDougall 1989; Hakansson 1989). Scholars conclude that strategic alliance is no longer strategic tool confined to larger firms and strongly recommend that small firms should pursue strategic alliances in order to grow rapidly.

Are these academic findings and recommendation convincing decision-makers of HTSFs that technology alliance is the technology-sourcing method most likely to be efficient and guarantee a successful outcome? Firm level data shows that they have contrasting views on technology alliance, although the vast majority believe that it will be an indispensable strategic tool for years to come. Gomes-Casseres (1997) found that the propensity to use alliance is bimodally distributed; some firms have a greater propensity to use alliance while others are less keen. He argues that 1st tier HTSFs refuse to share their technologies and insist on going it alone, while 2nd and 3rd tier ones prefer cooperative technology sharing. Rothaermel (2002) argues that cooperative strategies are attractive to HTSFs only if they have sufficient technological capabilities for innovation and locational advantages. Above all, the decision-makers are well aware that seven out of ten strategic alliances fails (Whippie & Frankel 2000; Deed & Hill 1996; Kotabe & Swan 1995); this inevitably makes them cautious about such ventures.

Then, under what conditions are HTSFs more likely to pursue strategic alliance (i.e., licensing, joint development or joint venture)? Do systematic differences arise when they pursue, for instance, licensing as oppose to joint venture? When are they be likely opt for cooperative mode as opposed to independent in-house development? How would scholars be able to advise the decision-makers who are planning new technology project and curious about how to assess the appropriateness of strategic alliance? To investigate these matters, it is crucial to consider several issues from the decision-maker's point of view. Tackling a new technology development project alone, for instance, allows a great independence and maximises the firm's own share of the benefits. Failure, on the other hand, could be disastrous for the small firm, since it has fewer resources to fall back on if things go wrong (Miles, et al. 1999). Forming an alliance may thus be advantageous, due to possible technology transfer, sharing of financial risk and increased production efficiencies (Lei & Slocum 1992). But, a small firm may run the risk of being in weaker position when it comes to thrashing out the details of the alliance with the larger one. If the small firm does decide to pursue technological collaboration, it may have a hard time wooing potential partners. Decision-makers need to measure the advantages and disadvantages of all technology-sourcing options and assess whether internal capability improvement is sufficient or whether partnership would be in their best interests (Steensma &

Corley 2000; Poppo & Zenger 1998; Harrigan & Newman 1990; Osborn & Baughn 1990). Ill-thought out decisions may spell disaster.

Dominant studies appear to presume that strategic alliance is inevitable and the only viable option for resource deficient small firms. They view that strategic alliance is now replacing simple market-based transactions and internalisation. Based on these assumptions, these studies dwell on how small firms can maximise the benefits from alliance or how one can identify the characteristics of successful alliances; (Alvarez & Barney 2001; Dyer, et al. 2001). However, the issue of when such alliances should be chosen is neglected. Why this excessive optimism about the strategic alliance? In light of the recent dot-com boom, researchers have been falling over themselves to unlock the secrets of a few dramatic success stories, involving small firms that have grown rapidly. They have found that their remarkable success is due to an aggressive growth-oriented and risk-taking strategy, combined with highly developed interfirm relationship for value creation.

The reality, however, is that majority of small firms are not always growth oriented, nor even willingly risk-taking (Autio 1994). It is unrealistic, then, to advise all other players to follow the path of a few successful small firms. Technology development and innovation are increasingly shifting towards a collaborative mode, but the outcomes are also increasingly uncertain. A better prescription for the majority of small firms, therefore, would be to indicate the optimal conditions *ex-ante* for choosing strategic alliance, rather than simply stressing the power of a cooperative strategy as a whole. Recognising the need for prescribing optimal condition for strategic alliance, some studies tend to work with discrete dichotomies, examining the choice between joint venture vs. wholly-owned (Mutinelli & Piscitello 1998; Hennart 1991), equity alliance vs. non-equity alliance (Domke & Damante 2000; Hagedoorn & Narula 1996; Nordberg, et al. 1996; Pisano 1989), alliance vs. wholly-owned (Contractor & Lorange 1988; Mang 1998; Erramilli & Rao 1993), in-house vs. licensing (Atuahene-Gima 1992), acquisition vs. collaboration (Chi 1994). Although informative, these studies are somewhat limited because they are based on the examples of large global firms. In addition, technology-sourcing methods are much broader realm of several careful decision-making processes and they are best grasped by investigating how decision- makers overview and evaluate them systematically.

1.3 Research question

This study raises two major research questions:

(1) Under what conditions, do high-tech small firms choose external sourcing modes (i.e., technology alliance) for new technology development? Under what conditions, do they choose internal development modes (i.e., in-house development) instead of external sourcing modes?

(2) Why do high-tech small firms choose different external sourcing modes for new technology development?

The main concern of this study is to explore under what conditions HTSFs are likely to form strategic alliances to develop new products or technology. These vital matters are reflected in research questions 1 and 2. The research question 1 demands exploration of the extent to which strategic alliance is seen as a desirable competitive strategy among HTSFs under specific conditions. Which factors influence the managers of HTSFs to pursue or reject technology alliance? Research question 2 also pins down why HTSFs choose different modes of governance when they pursue a strategic alliance. As we will see in the following chapter, various modes of technological alliance exist, each with its own unique strategic features. Previous empirical studies have revealed that the choice of governance mode of technological cooperation varies widely across different firms. Therefore, it will be interesting to identify and test the factors influencing the governance structure of various technology alliance mode.

The unit of analysis in question 1 and 2 is the firm (the firm's decision-making). The targeted population group will be carefully selected based on whether the HTSFs involved have made significant technology-sourcing decisions in the course of their business careers. Of course, almost all HTSFs involve such decision-making; some, of course, more than others. No official data, though, is available on this issue. By questioning each firm in the population group directly, this study will consider only single case of significant technology-sourcing decision critical to the firm as a whole. Considering one case for every single firm helps to avoid double counting and report bias, firms can interpret the phrase 'the significant technology sourcing decision' in various ways. The followings are a clear specification that pins down precisely which technology sourcing decision is meant for each firm;

- -Technology-sourcing decisions made no more than three years ago and no later than 12.31. 2002 are examined.
- -Only one case of technology-sourcing decision, representative of and significant to the firm's technological innovation is examined in each case.
- -Representative and significant innovation does not mean a simple enhancement or a minor line extension of an existing product, but that which advances the technology in the product category.
- -'Technology-sourcing decision' refers to a firm's strategic decision in order to continuously improve existing products, processes and services through the introduction of new ones
- -For the sake of simplicity, the most significant R&D project conducted during the past three years is examined.

1.4 Research scope and method

In strategic management studies, a tight research design is always necessary to control the impact of the geographical, industrial and situational factors. Tight research design reduces 'noises' , factors that contaminate the true relationship between explanatory and outcome variables. In this sense, this study will focus on one geographical area, one-industry and representative samples can minimise the impact of these extraneous factors on the results of the analysis.

This study will concentrate on the HTSFs in developing nation, because previous research on technological collaboration has mainly targeted multinational enterprises in the developed world (Vyas, et al. 1995). Technology collaboration, however, is no longer restricted to large firms in developed nations. Significant rates of growth in interfirm alliances in the IT sector during the past 10 years have been accompanied by even faster alliance growth among firms in newly industrialised countries (NICs) (Vornotas & Safioleas 1997). South Korea is chosen as a target of NIC. South Korea is recognised as one of the most successful economic development models among NICs and she saw the emergence, growth and success of many HTSFs during the 90s. Their role in economic growth and technology leadership has often been attributed to their active participation in strategic alliances for organisational learning and technology development. Alliance formation by Korean HTSFs has increased six times over the last decade. Hagedoorn (2000) argues that South Korea is the front-running developing nation, matching the EU, US and Japan in terms of alliance formation in the high-tech industry.

The new wave of technology alliance in the Korean small business sector is qualitatively different from that of traditional alliances. Previously, small Korean firms had used OEM and short-term product supply agreements with large conglomerates, utilising their *given* technological capability. Recent technology alliances, meanwhile, involve broader scope and more strategic 'corporate purpose' aimed at gaining new capabilities. A fresh look at the competitive strategy of small firms such as technology alliance in NICs is vital.

Technology intensive industry consists of many industrial sub-categories. The telecommunications sector is one of Korea's fastest growing industries; the majority of HTSFs are working in areas such as mobile communications devices, communications software, internet solution and semiconductor/accessory/material. In this R&D intensive industry, firms face enormous pressure to come up with new technology. The present work assumes that technology-sourcing decisions and technological collaboration constitute these firms' major competitive strategic issue; so it will provide rich empirical evidences regarding this study's research questions. Although a single industry study often lacks generalisability, it does afford greater control over sources of extraneous variation such as different industry characteristics, environmental noise, and the like (Mohr & Spekman 1994).

This study will adopt both quantitative and qualitative approaches. The quantitative part will take deductive/theory-testing approach using hard data from the mail survey and secondary data sources. Extensive literature will be reviewed in order to understand the phenomenon, identify hypothesised relationships and design as succinct but a complete questionnaire as possible. Prior to undertaking quantitative part, the qualitative part will undertake a pilot case study of three representative firms from the sample. This will help test the efficacy and validity of the survey constructs, the instruments, case instruction and key concepts. Also, an in-depth interview with CEOs and key decision-makers in those firms will provide insights on the validity of determinants elicited from the previous studies. Based on the pilot case study, a more finely tuned survey questionnaire will be designed to improve internal and external validity of the study. The final version will be mailed to target firms via e-mail, fax and registered post.

1.5 Contribution of the study

The contribution of this study is threefold. First, arguing that alliance is not an organisational panacea for all HTSFs, this study will investigate the conditions under which the Korean HTSFs are more likely to choose technology alliance. By taking this research, we can explore why not all HTSFs are actively pursuing technology cooperation despite the benefits and advantages that it may allow. This approach is quite rare in alliance studies in newly industrialised nations as the majority of them focus on the effect of alliance in the organisational performance. For policy-makers in government bodies, this study will provide valuable empirical data on the present status of the collaboration activities of Korean HTSFs and how to promote them.

Second, at management practice level, this study will provide some insights with an analytical framework. Newly-established Korean small firms may find it difficult to decide the boundary of organisational activities when they plan new product innovation projects. The framework, which will be suggested in the following chapters, may speak largely for itself, but several aspects of it are worth emphasising from the practising manager's point of view as the variables and their theoretical rationale will help small Korean firms to identify and quantify essential decision-making factors.

Third, transaction costs economics is facing severe criticism by many alliance scholars. They argue that it does not provide the most suitable theoretical framework to explain the antecedents of alliance formation by small firms. For instance, the resource-based perspective argues that small firms choose alliance for the purpose of inter-organisational learning and value creation, rather than as a result of their rational and logical calculation that doing so would be the most economic way of undertaking the organisational activity at the minimum costs (Coombs, et al. 1996). However, none of the scholars has paid sufficient attention to these divergent views and examined them within the context of the HTSFs. In this respect, this study is firstly contributing to the academic field of alliance studies by assessing the extent of the explanatory power of each view.

1.6 Structure of the thesis

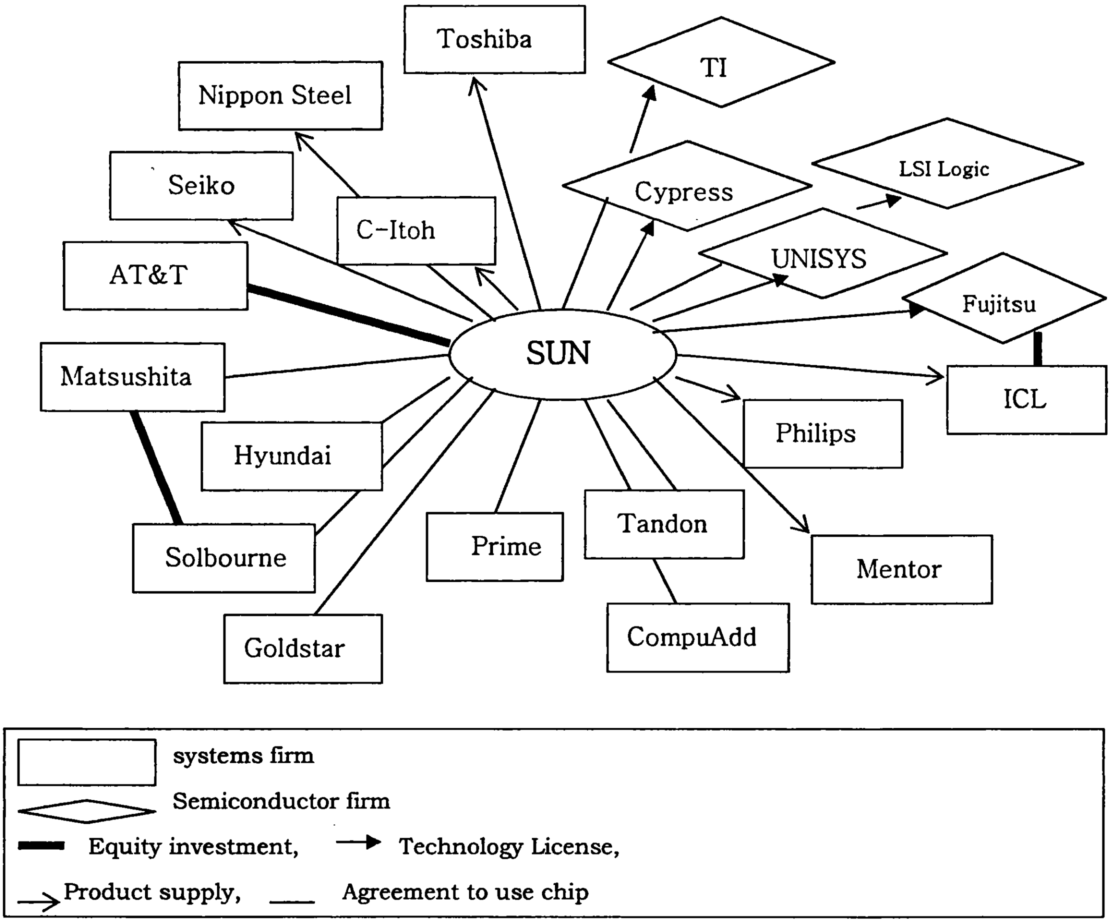
This study consists of 10 chapters. Chapter 2 conceptualises fundamental issues in alliance studies including definition, governance mode, alliance motivation and types of partners. Chapter 3 details technological collaboration activities among Korean HTSFs in the telecommunications industry, including their emergence and growth, government policy, their contribution to the Korean economy as a whole and their technological collaboration activities in general. Chapter 4 presents the literature review focusing on the antecedents of technology alliance formation. Five major theories from economics and sociology are selected and reviewed. Based on the implications of chapter 4, Chapter 5 outlines a theoretical framework that casts light on conditions under which Korean HTSFs opt for a technology alliance for new product development. A two-stage contingency model is developed. Chapter 6 summarises the research framework, and presents definition of hypotheses and variables and their operationalisation. Chapter 7 clarifies the data collection method and the results of descriptive analysis from the survey explaining the pattern of technology alliance use by the respondents. Using bivariate and multivariate statistical analysis methods, chapters 8 and 9 present empirical results of the hypotheses derived from the research framework. Chapter 10 concludes the thesis with a discussion of the theoretical and practical implications of the research findings. Research constraints and opportunities for future study are then put forward.

Chapter 2. Fundamental issues in strategic alliance studies

Introduction

No firm exists in absolute isolation. Throughout its business life, a firm is involved in web of relationships with other organisations. Top 500 global firms have an average of 60 major strategic alliance each (Dyer, et al. 2001). The example below shows how the Sun Microsystems (US computer network, hardware, software provider) enthusiastically relied on other organisations such as Netscape, IBM and Oracle to help develop new software for Java technology.

(Figure 1) Sun Microsystem's alliance network in 1992



(Gomes-Casseres 1997)

Example above clearly demonstrates that high-tech firm views strategic alliance as a useful means of gaining access to critical resources (i.e., technology) beyond the boundaries of their own firms. Do small-sized firms in a high-tech industry take similar strategic actions, forming similar patterns of numerous interfirm relationships with other firms for various strategic purposes? How can we characterise their complex interfirm relationship such as their partner types and cooperation modes?

The focus of this chapter is to clarify the fundamental parameters of strategic alliance: the rationale behind the alliance formation, cooperation partner and types of cooperative arrangement. The first section will define the meaning of strategic alliance and identify its various functions. The second and third sections will review the motivations underlying technology alliance, and examine the diverse modes of technology alliance and their unique feature in terms of control, duration and function. Alliance partners constitute an increasingly diverse group, thus, listing all of them help us understand the partner preferences of HTSFs. The definition and classification of the three parameters is crucial, yet the extant academic literature has failed to tackle this. Some research muddles up alliance definitions and ignores emerging new types of alliance, making prescription difficult and confusing both practitioner and researchers. This chapter will tackle this issue also.

2.1 Conceptual foundation of strategic alliance

■ Definition of strategic alliance

The term 'strategic alliance' has been abused. Scholars have frequently used the term interchangeably with other terms, and have offered definitions without making reference to contrasting uses of the term. Economists call it a hybrid or hybrid arrangement, because it involves attributes of economic exchange found in both market and hierarchy (Williamson 1991). Sociologists view it as a form of social institution in which cooperative relationships are socially contrived for collective action. It is, some theorists argue, continually shaped and restructured by actions and symbolic interpretations of the partners involved (Ring & Van de Ven 1994). For organisation theorists, strategic alliance is a strong form of inter-organisational relationship that requires constant input into the partnerships and collaborative agreements (Yoshino & Rangan 1995; Auster 1994; Larson 1992; Kogut 1988). Lastly, strategic management scholars call it 'partnership' or 'coalition' and see it as a form of strategic manoeuvre that consolidates the parent firm's competitive position (Yosino & Rangan 1995; Auster 1994; Larson 1992). The following table shows more examples of terminology equivalent to strategic alliance.

(Table 1)Terminology of strategic alliance

Terminology	**Researcher**
Strategic alliance	James 1985; Harrigan 1987; Hill & Kim 1994; Yoshino & Rangan 2000; Lorange & Roos 1992; Perker & Allio 1994; Kotabe & Swan 1995
Coalition	Harrigan & Newman 1990
Collaborative agreements	Morris & Hegart 1987
Collaborative relationships	Mitchell & Singh 1996
Competitive collaboration	Hamel, Doz & Prahalad 1989
Cooperative arrangements	Teece 1986; Gugter & Dunning 1993
Cooperative strategy	Harrigan 1988
Cooperative inter-organisational relationship	Ring & Van de ven 1992
Hybrid organizational arrangement	Heide & John 1990; Heide 1995
Interfirm cooperation	Shan, Walker & Kogut 1994
International collaborative agreement	Morris & Hegert 1987
Interfirm corporate linkage	Auster 1987
Interorganizational collaboration	Powell, Kogut & Smith-Doerr 1998
Interfirm coordination	Buckley & Casson 1998
Strategic linkage	Nohria & Garcia-pont 1991
Strategic partnership	Permuter & Heenan 1986
Alliance network	Gomez-Casseres 1994
Partnership	Hagedoorn, et al. 2000
Network organization	Miles & Snow 1992; Peter & Smith Ring 1996; Powell 1990; Uzzi 1996, 1997
Network governance	John, et al. 1997
Quasi-firm	Eccles 1981
Value added partnership	Johnson & Lawrence 1988
Cooperative arrangement	Contractor & Lorange 1988
Strategic outsourcing	Quinn & Hilmer 1994
Strategic partnering	Finnie 1993
Virtual firm	Powell 1998

(Adapted from John, et al. 1997)

This terminological morass exhibits a common theme; strategic alliance is a dynamic process by which individuals, groups and organisations come together, interact and form psychological relationships for mutual gain and benefit.

This study defines strategic alliance as a voluntary co-alignment and agreement between two or more firms or organisations with a shared commitment and pooled information to reach a common goal by brining complementary resources together and coordinating their activities (Lorange & Roos 1993; Teece 1992; Hamel 1991). This study will use the terms 'strategic alliance', 'collaboration', 'partnership', 'cooperative strategy' and 'coalition' interchangeably. A strategic alliance, regardless of its specific structure, should meet the following fundamental conditions to prevent further confusion. First, through the strategic alliance, a partner firm can gain knowledge, products, skills, technology and distribution benefits that are otherwise unavailable to it (Hamel 1991). Second, a strategic alliance should ultimately aim at achieving competitive advantages by improving innovative efficiency or excluding competitors, rather than simply exchanging skills and products for short-term operational reasons (Varadarajan & Cunningham 1995). Relationships based on on-the-spot contracts and operational-efficiency (i.e., technology buyback or bartering) are thus not included in the term of the strategic alliance. Third, partners in the alliance should not lose their identity through their relationship and must be free to exit whether their goal is achieved or not (Yoshino & Rangan 1995). Thus, mergers and acquisitions are not considered as a strategic alliance. In sum, strategic alliance is a close, long-term, mutually beneficial agreement to enhance the competitive position of each partner; this definition is consistent with the notions of many scholars (Smith, et al. 1995; Yoshino & Rangan 1995).

■ Classification of strategic alliance

Strategic alliance can be categorised in many ways. The table below gives an overview of selected criteria and characteristics, followed by more detailed explanation of the most relevant ones.

(Table 2) Classification criteria

Classification criteria	**Extensions**	
Duration of collaboration	Strategic	One time

	(long-term collaboration)	(Short-term, one project)
Value chain focus	Vertical (cooperation along value chain)	Horizontal (cooperation on one stage of value chain)
Functional focus	Resource (internal) view (procurement, R&D, personnel)	Market (external) view (distribution, customer-oriented)
Differentiation of partner role	Focal (dominated by one partner)	Polycentric (partners have similar influence)
Stability of network group involved in value creation	Dynamic (partners involved depend on specific project)	Stable (always the same partners involved)
Industrial sector focus	Production	Services
Regional sector focus	Global	Local
Settlement nature	Contract based	Trust based

(Adapted from Riemer, Klein & Selz 2002)

The dominant literature tends to classify strategic alliances in terms of their industry scope (intra- vs. inter-industry), geographical scope (intranational vs. international) and functional scope (Varadarajan & Cunningham 1995). Within the industry scope, an intra-industry alliance means that alliance partners tend to be rivals competing for market share in the same product such as NUMMI (GM-Toyota joint venture) or *Keiretsu*. An inter-industry alliance means that the alliance partners tend to be firms competing in either related or unrelated industrial areas. Examples of geographical scope include prosperous alliances among Triad (US, EU, Japan) firms and among Pacific Rim (South Korea, Hong Kong, Taiwan, Singapore) firms. Scholars suggest seven functional areas within the firm: finance, management information, R&D, product design, marketing and sales/distribution (Grant 2002); an alliance is adopted to improve one or more of the functional areas, affecting productivity, technological development and production. According to the functional scope perspective, there are five types of alliance: supply alliance, production alliance, marketing alliance, capital alliance and technology alliance. Alliance are, however, rarely limited to a specific functional area with single activity, and tend to encompass several functions across the value chain.

Technology is increasingly the focus of collaboration, and technological collaboration is appearing in a wider range of industrial sectors and firms (Dodgson 1993). Technology scholars classify alliances into three major categories: alliance with technology content (covering technology development/innovation or R&D effort); alliance without technological content and mixed alliance (Vonortas & Safioleas 1997). Alliances without technological content mean those covering only supply agreements, marketing agreements, sales and distribution agreements, joint-production, second sourcing and equity-investment agreement. Alliances with technology content refer to R&D agreement, technology licensing, cross-licensing, technology assistance agreement, technology trade and university-industry cooperation. Mixed alliances are those that combine the characteristics of the other two categories. Empirical data reveals that most strategic alliances are devoted to functional areas related to technological development, and a number of alliances entail substantial technological content (Dodgson 1993; Hakansson 1989). In general, 'technology alliance' indicates either an alliance with technology content or a mixed alliance.

Like Dodgson (1993), this study defines technology alliance (or technological collaboration) as any activity where two or more partners contribute differential resources, technological know-how and skills to agreed complementary aims in order to keep pace with technological advancements in the market place. Ultimately, the goal of technological collaboration is to develop technology. This study uses a broad definition of technology. It is a body of knowledge, tools and techniques derived from science and practical experience, which is used in the development, design, production and application of products, processes, systems and services (Abetti 1989). It also includes new product innovation as well as new processes or methods by which outputs are generated (Tyler & Steensma 1995). In this study, however, technology alliance does not include one-time only contracts, general technological monitoring or the recruitment of technological personnel; it deals rather with on-going arrangements in which partners share their expertise and output. Firms may engage in technology collaboration with other organisations (suppliers, customers, and occasionally competitors) and with higher education institutes and contract research organisations. The full range of technological collaboration is too broad to be considered fully here. This study will focus on a more restricted type of collaboration, in line with much of the research on small firm' alliances.

2.2 Mode of technology collaboration

R&D collaboration, research joint venture, research contract agreement, and technology sharing, are examples of technological collaboration. They are distinct, in that they have unique attributes relating to terms and conditions, flexibility, time horizon, establishment costs, level of technology sharing, level of risk and ownership and control (Mueller & Herstatt 2000; Butler & Sohod 1995; Osborn & Baughn 1990; Buckley & Casson 1988; Contractor & Lorange 1988; Auster 1987). Different organisational designs of technology alliance have divergent effects on market structures and on the economic performance of participating firms (Hagedoorn 1990). Firms choose the alliance mode appropriate to their strategic objectives, partners preference and ability to learn (Chiesa & Manzini 1998; Hagedoorn & Narula 1996; Borys & Jamison 1989). This does not necessarily mean, however, that firms sharing the same objectives, partner preference and learning ability will choose the same modes of technology alliance.

Unfortunately, many studies still use the term technology alliances to refer only to research joint ventures. They assume that other forms of cooperation share identical features under the heading of 'strategic partnership'. In addition, existing classifications of technology alliance take it for granted that technological cooperation represents only a legal and formalised relationship in which the contracting mechanism explicitly defines the role of participants and guides their inter-organisational activities (Harrigan 1988; Kogut 1988). The legal and formalised relationship, though, is only part of the extensive collaboration activities of small firms. Small firms are keen on informal linkages with other organisations because it is less costly and risky to establish but equally as efficient as formal linkages. We should note that by far the most common form of small firms' cooperation is still informal in nature; significant amount of innovative ideas come from this source (Lee 1995; Rothwell & Dodgson 1991). This section will thus illuminate both the informal and formal modes of technology alliance that are most often utilised by technology intensive firms.

■ Informal vs. formal technology collaboration

Informal collaboration presents problems. There is no systematic way to track it quantitatively, far less study it in detail (Hagedoorn, et al. 2000). Informal collaboration means mutual exchange of information without any formal structure of control, legitimate authority or systematic integration. It involves adaptable arrangements in which behavioural norms (management dynamism, organisational flexibility, rapid communications and high degree of adaptability) rather than dense contractual obligations determine the contributions of parties (Smith, et al. 1995). Sociologists view it as a loosely coupled and personalised system entangled in multiple external networks (Gronovetter 1973). Recent research indicates that innovative small firms lean heavily on informal linkages with external agencies to complement their in-house technological capabilities (Lee 1995; Rothwell & Dodgson 1991). Examples of informal collaboration include technological advice provided by equipment and material suppliers (Lee 1995). Buyers are occasionally an important initial source of stimulus, through serious technological inquiries and feedback. Technological support and guidance from domestic R&D institutes, consulting firms and universities have been useful tools for technological innovation. In Korea, government agencies, which include government-sponsored information centres, technical assistance institutes, and industry associations, have been strengthened in their function of encouraging and supporting small firms' technological innovation. Forming informal linkages with these groups, HTSFs can access specialist facilities, non-core technical activities and, above all, gain a window on emerging technology and new innovative ideas (Tidd & Trewhella 1997).

Why are informal technological linkages to external agencies so popular to many HTSFs? First, in most cases, developing new technology is usually an integral part of overall corporate operations. Also, most technological development projects are so diverse in nature that it is difficult to define them in formalised agreements (Lee 1995). Second, management of a formal relationship is often entails complex problems. Small firms require a high level of management skills to motivate and organise creative collaborative arrangements, this they often lack. Third, a small firm's ability to access and form formal arrangements is conditioned by its in-house employment of qualified technological specialists. Lack of suitably qualified scientists and engineers can inhibit the small firm's ability to assimilate and further develop technological know-how within a formal relationship (Rothwell & Dodgson 1991). As a result, many small firms prefer to informally partner with one another on short-term research endeavours and project-specific research (Hagedoorn, et al. 2000). Nevertheless, informal alliances involve limitations. Technological innovation requires frequent face-to-face interaction between partners on a regular basis and strong mutual recourse in order to deal with complex and intellectually intense and challenging tasks (Coombs, et al. 1996). Informal collaboration is not an option in this case.

In formal collaboration, major technology transfer and exchange takes place through formal channels such as licensing agreements R&D contracts and joint ventures. Unlike informal collaboration, formal collaboration is characterised by contractual obligation and formal structures of control between the organisations involved (Hakansson 1989). In the media, non-professional publications and academic literature, 'strategic alliance', 'collaboration', 'partnership', 'coalition', usually denote formal collaboration. No systematic attempts have been made to pin down the distinctive features of formal and informal collaboration in respect to strategic, competitive, managerial and organisational implications. Few scholars mention that while informal collaboration is formed mainly during the early stage of technological innovation (basic and explorative research), formal alliances are formed during the later stage (applied research) (Chiesa & Manzini1998). Formal collaboration, in contrast to the informal variety, typically involves long-term and recurrent contracting (repeated exchange of assets based on trust) (Ring & Van de Ven 1992). Above all, formal collaboration is driven more by precise intentions and organisational strategies than by accidental opportunities, thus, it is more pivotal to the whole corporate strategy of a firm (Kreiner & Schultz 1993). The next section analyses formal technology alliances in detail.

■ Equity vs. non-equity collaboration

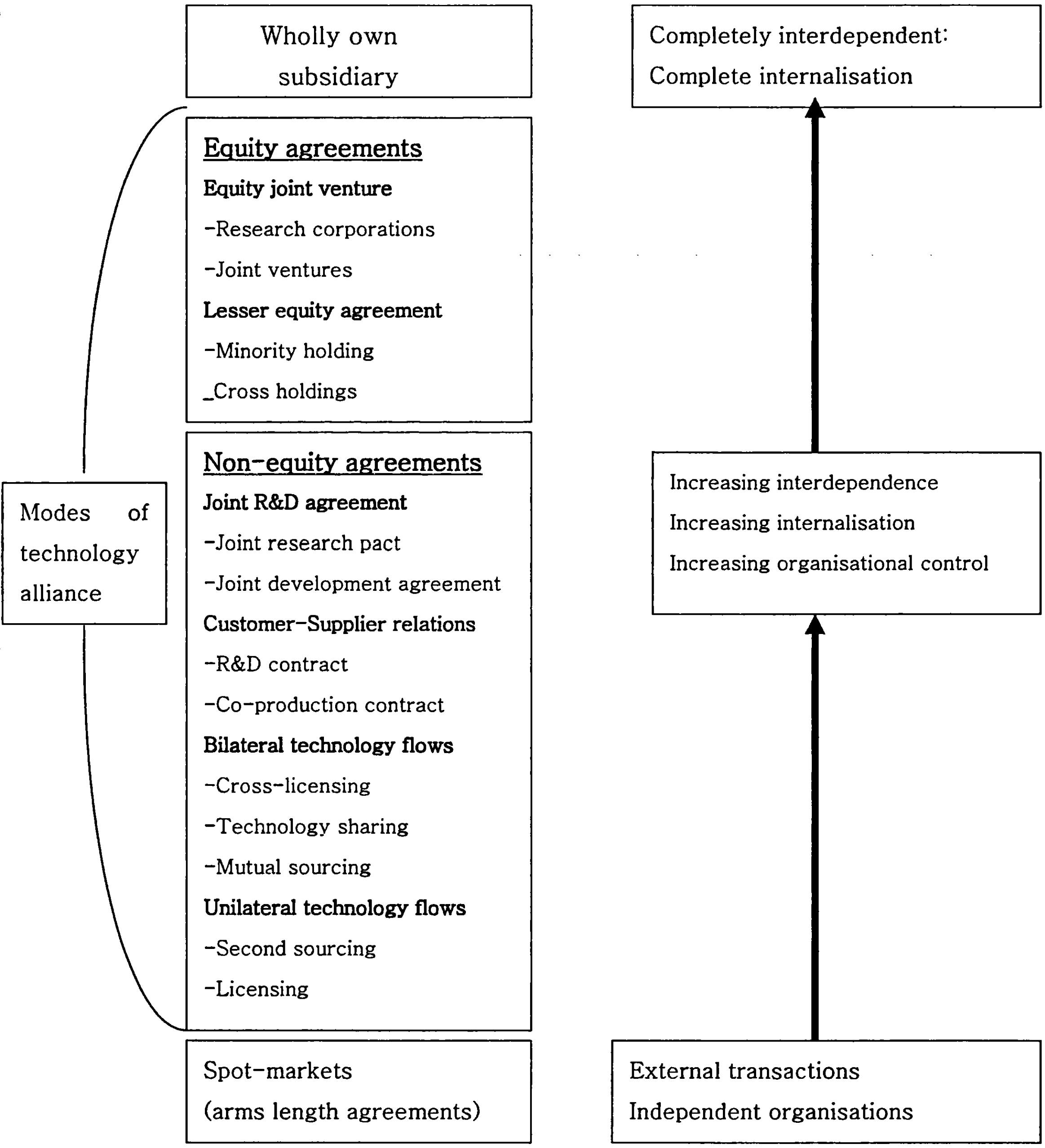
There are two main types of formal collaboration: equity alliance and non-equity alliance. The division between them is determined by whether both partners are taking equity position (shared ownership) in others (Shaw & Kauser 2000; Minshall 1999; O'Farell & Wood 1999; Contractor & Kundu 1998; Das & Teng 1997; Gulati 1995). Whereas equity alliances include equity exchange by creating a new entity or minor equity investment, non-equity alliances refer to all other cooperative arrangements that do not involve equity exchange. Example of equity alliance includes minority equity partnership (minority equity stake), joint research corporation and joint venture (Yoshino & Langan 1995). Examples of non-equity alliances include unilateral contract-based alliances and bilateral contract-based alliances (Mowery, et al. 1996). Alliances are unilateral-based when they embody a well-defined transfer of property rights such as licensing agreements, second sourcing and R&D contracts and individual firms carry out their specific and complete obligations independently of others (Das & Teng 2000). Alliances are bilateral-based when partners bind their resources and work more tightly together but the contract is incomplete and open-ended (Das & Teng 2000). Examples of bilateral-based alliance are joint R&D agreements, cross-licensing, and mutual second sourcing, etc. The following table summarises the characteristics of equity and non-equity alliances.

(Table 3) Distinguishing characteristics of equity and non-equity alliance

	Alliance structure	
Distinguishing characteristics	**Equity alliance**	**Non-equity alliance**
Ownership structure	Joint equity and one-way or cross equity ownership	No shared ownership involved
Degree of interfirm integration	Substantial: Equity participation or working within one entity	Moderate to light: Working jointly or separately according to the contract
Control mechanism	Hierarchical and/or through equity stakes	Contract law
Temporal duration	Long to medium term	Short to moderate term
Unplanned alliance termination	Difficult: (1) Joint ventures to be taken over by one partner or third parties (2) Selling equity stake to the partner or third parties	Relatively easy: Simply end the contract

In principle, an equity alliance represents a higher level of integration (internalised), control and inter-organisational interdependence than a non-equity alliance. Although there is no clear and agreed definition, the 'level of integration', can be seen as the extent to which the accessed activities and resources involved in a collaboration are integrated (internalised) within the firms own activities and resources (Chiesa & Manzini 1998). The control mechanism is a regulatory process by which the elements of a system are made more predictable through the establishment of standards in the pursuit of an objective (Das & Teng 1998). The level of interdependence is the degree of reliance between partners in terms of shared commitment and resources (James 1995; Hagedoorn 1990). Figure 2 shows how several modes of strategic alliance are constructed with different degrees of control, integration and interdependence, all of which are interrelated.

(Figure 2) Organisational modes of interfirm cooperation and extent of their interdependence, integration and control



(Adapted from Narula & Hagedoorn 1999; Hagedoorn 1990)

As seen in the figure 2, the level of interdependence ranges from wholly owned, which represents complete interdependence to spot-market transactions wherein totally independent firms engage in arm's length transactions with complete independence from each other (Narula & Hagedoorn 1999). Formal collaboration is located between two extremes; equity alliance modes are closer to the hierarchy while non-equity alliance modes are closer to spot-market or arms length agreements. Scholars point out that equity alliance modes have quasi-hierarchy attributes in that partnering firms are less opportunistic, better monitored, better controlled in attaining goals, there is a high degree of interdependence between players and strongly committed to each other (Hagedoorn & Narula 1996; Gulati 1995). On the other hand, non-equity alliance modes have quasi-market attributes, in that breaking up and re-organising costs are cheaper, and management is more flexible, taking a shorter time to achieve visible outcomes (Osborn & Baughn 1990). However, non-equity alliance modes are much stricter in terms of contract specification and rely more on third party enforcement in case of disputes (Osborn & Baughn 1990). Table 4 summarises the diverse modes of equity and non-equity technology alliance and provides definitions. These definitions are not clear-cut; practitioners often use terms interchangeably.

(Table 4) Definition of major technology alliance modes

Alliance type	**definition**
Equity joint venture	Two parents companies establish a new and separate third company with a definite objective. 50:50 equity sharing for each partner is usual. Profits and losses are usually shared in accordance with the equity investments by the parent companies.
Minority investment	An acquisition of equity shares by one or more parents with normally less than 30 per cent of the whole shares. But the acquiring firm(s) do not have management control.
Research corporation	Joint R&D ventures with distinctive research programme.
Joint production (co-production agreement; co-makership relation)	An agreement between partners to produce a commodity; usually the leading company supplies the technology and the critical components and the other company manufactures less critical components and assembles final products. Tends to be a long-term contract based on close contact and quality control which are usually set by the leading partner.
Joint R&D (joint R&D pact, joint development agreement, R&D contract)	The partners combine their R&D efforts and share rights to the product/service without any equity involvement. Usually, a company agrees to fund the costs of R&D at a research institute, university or small innovative firm for a definite technology in return for sharing market rights to the product/service.
Single licensing	One company (licensor) which has the property rights gives

agreement	another company (licensee) the right to use or access in return for payment or fee.
Cross-licensing agreement	Bilateral form of licensing where companies usually swap packages of patents to avoid patent infringement or to exchange existing codified technological knowledge.
Second sourcing	Transfer of technology through technical product specification in order to produce exact copies of the products.
Sponsored spin-outs	The large company offers financial backing for entrepreneurial employees to spin-out to form a new small firm to exploit technology development within the parent company, but which is deemed unsuitable for in-house exploitation
Independent spin-out assistance	The large company offers technical assistance to an independent spin-out and sometimes acts as first customer for its products. Pre-payments can provide a crucial source of income to the new company
Venture nurturing	The large company offers not only financial support to the sponsored spin-out, but also access to managerial, marketing and manufacturing expertise and, if appropriate, to channels of distribution
Client-sponsored research contract	The small company is paid to conduct research on particular products or processes for another organisation
University agreement	An agreement with a university whereby the high tech small firms pay the university to conduct research on its behalf

Academic literature used to approach formal collaboration under the heading of 'competitive collaboration strategy', while overlooking the significance of non-contract mediated relationships. As mentioned above, small firms still rely heavily on informal collaboration or personalised networking as their major source for technology development. Despite an academic attention focus on equity alliances such as joint ventures and research corporation, the number of firms adopting equity alliances has decreased substantially (Hagedoorn 1990). Since the mid 80s, non-equity agreements such as joint R&D agreements have ousted the equity alliance as the most popular type of formal collaboration.

In summary, we have seen the spectrum of technological cooperation including informal collaboration (usually through the short-term exchange of research personnel, ideas and/or laboratory materials without forming any written contract) and formal collaboration (six or more months of long term relationship based on written agreement between partners to create new or improved products/services). A range of cooperation activities occurs when independent enterprises put together a commonly defined R&D project, often with the help of universities and government-run-laboratories. Modes of alliance differ widely in terms of flexibility, control, time horizon and level of integration. The decision to choose one mode has to be built on a clear evaluation and must be closely matched with the firm's needs.

■ Typology of partners involved

The key feature setting strategic alliances apart from other single-firm strategies is the involvement of partner(s), which involves risks; partner firms may cheat, shirk, distort and mislead one another (Das & Teng 1998). Therefore, a firm must select cooperative partners who pursue mutually compatible interests and avoid opportunists. Traditionally, the major alliance partner of small firms used to be a large firm. The small firms supply finished products to a large firm, and in return, the large firms transfer technological know-how and supply suggestions to small firms based on user experiences (Rothwell & Dodgson 1991). In this supplier/manufacturer relationship, both partners are involved in technological and 'customer-need' informational exchange. Empirical results show that four fifths of technological collaboration among HTSFs is 'vertically related', undertaken jointly by customer and supplier (Hakansson 1989). Recent studies, however, show that HTSFs are not restricted to large customer firms but include similar-sized competitors and even companies in unrelated industrial areas (Thether 2002). This section, therefore, will introduce various types of small firms' alliance partners and their relational attributes.

Alliance partners can be classified in several ways. Prominent informal alliance partners are R&D laboratories, government research organisations, major universities and a broad range of technological specialists (Mackun & MacPherson 1997). The technological specialists include contract R&D companies, industrial design consultancies, private testing laboratories and engineering consultancies. Veugelers and Cassiman (1999) note that informal consultation in specialised conferences, meetings, and seminars also involve partner-like behaviour through informal discussion and advice. In this sense, universities have been the most frequent informal collaboration partner for HTSFs (Tidd & Trewhella 1997). An example of this is supporting studentships for PhD students and research awards for post-doctoral staff to carry out specified research. The advantage of relying on these external sources is that they provide quick and easy assess to stocks of scientific and technical inputs or knowledge.

Formal alliance partners can be classified several ways. First, there is a vertical collaboration in which the suppliers and customers become the partners. This relationship is highly flexible in its duration (mostly short- and medium-term oriented), so that the partners can terminate the relationship in case the cooperation does not seem to be efficient. The role and tasks of the partners in this relationship are fairly clear, as is the formality of the contract. Studies indicate that eighty per cent of vertical alliances are highly formalised, involving a contract with a definite time horizon, objectives and rules. On the other hand, horizontal collaboration often involves competitors working in the same industry, and is frequently considered during the early phases of the innovation process or in the basic and applied research area (Teece 1986). Due to a high level of uncertainty regarding objectives, time horizon, partner roles and outcomes, horizontal alliance demands firm control over information flows and medium- and long-term commitment. This is why alliance with competitors often takes the form of a long-term relationship. Newer and smaller firms frequently form interfirm relationships with competitors in order to establish a standard sharing whereby they can prevent rapid copying of their costly but easily imitable technology by the dominant incumbent (Tether 2002).

Alliance partners can be classified in terms of cultural difference (nationality). When partners are from different countries, transaction costs caused by cultural, institutional and social barriers can make the collaboration process difficult. In this case, studies suggest that a weakly integrated mode of alliance, which does not have a great impact on the firm's organisation and human resources, is preferred (Hitt, et al. 2000). Alliance partners can also be classified in terms of bargaining power (i.e., firm size). More powerful partners (larger firms) tend to choose a hierarchical, rigid, controlled or formal mode of collaboration in order to impose conditions on the less powerful partners. Small firms who may not effectively manage the formal relationship face the risks of being in a less powerful position when it comes to negotiating alliance arrangements (Miles, et al. 1999). That is why small firms prefer non-equity types of relationship even if they are bringing a key piece of knowledge or technology to the relationship (Hagedoorn 2000).

With whom should the HTSFs be partnering? Studies have shown that small firms meet their partners through chance meetings or through previous experience with small and large business partners with whom they incrementally expand their relationship into cooperation (BarNir & Smith

2002; Hite & Hesterly 2001). Unfortunately, such studies have generally been vague or silent about which criteria a small firm might use in attempting to select a 'complimentary' partner. Partner characteristics greatly influence the operation and results of alliance. Small firms, therefore, should carefully examine a potential partner's financial stability, reputation, culture, size, degree of shared decision-making, trust level and strategic similarity (Saxton 1997; Geringer 1991). The present work, however, stresses two major points that small firms should bear in mind prior to choosing a strategic alliance. First, alliance is not a cure-all for all firms, thus, the HTSFs should build itself first as a viable independent entity (Miles, et al 1999). If it fails to do so, the firm will not reap the full benefit of an alliance, no matter how successful it may be. Second, a relationship always benefits from experience (Slowinski, et al. 1996). One president of a small Korean telecoms company admitted that his initial alliance could have been more effective if he and his partner had been more experienced in cooperative management. Therefore, before considering a closer relationship, HTSFs should rehearse with a loose alliance, such as selling their product, to examine whether both parties work well together (Donckels & Lambrecht 1997).

2.3 Motivation of technology alliance

What is the aim and purpose of a strategic alliance? What do alliance engaged firms expect to realise from the cooperative relationship? Various studies have listed the reasons and motivations of strategic alliance (Das, et al. 1998; Mowery, et al. 1996; Contractor & Lorange 1988; Harrigan 1986). These can be broadly characterised as attempts to capitalise on opportunities for sales; achieve profit growth at lower costs; promote a present product for a present served market; enter into new product-market domains that are either related to or unrelated to the present product-market domain (Varadarajan & Cunningham 1995).

All firms obviously want to benefit from alliance. Vyas, et al. (1995) suggest two major reasons for alliance: market-related vs. technology-related motivation. The formal is related to the rationalisation of the product, the latter is related to technological breakthrough in a tough competitive environment. Koza and Lewin (1998) identify two major alliance motivations: exploitation vs. exploration. An exploitative alliance aims to enhance the firm's capabilities by building on existing assets and capabilities, while explorative alliance aims at elaboration and incremental improvement by discovering new opportunities. Sakakibara (1997) suggests two major motivations: cost-sharing vs. skill-sharing. Similarly, Hagedoorn (1993) and Narula and Hagedoorn (1999) see two major alliance motivations: cost-minimising vs. strategic-related. Cost sharing or cost minimising alliance aims to lower the costs of some of the firm's activities by sharing costs and risks with other partners, while strategic-related or skill-sharing alliance is similar to explorative alliance--developing new technological capability and market opportunities.

Such dichotomous approaches are simplistic; real world motives are more complex. Glaister and Buckley (1996) identify eight alliance motivations based on previous studies and several theoretical explanation, as detailed in the table below.

(Table 5) Motivation of strategic alliance

Motivation	Theoretical explanation
1. Risk sharing	Main stream economics, transaction cost theory, resource dependence theory
2. Product rationality	Main stream economics
3. Transfer of technology, exchange of patent, organisational learning	Transaction cost economics, resource based theory
4. Shaping competition	Strategic positioning theory, main stream economics
5. Government policy	
6. Facilitate international expansion	Resource based theory, strategic positioning theory
7. Vertical links	Main stream economics, transaction cost economics, resource dependence theory
8. Consolidate market position	Strategic positioning theory

(Adapted and revised from Glaister & Buckley 1996).

Similarly, Varadarajan and Cunningham (1995) identify eight underlying alliance motivations, as seen in the table below.

(Table 6) Motivation of strategic alliance

Motivation	Specification
1. Market entry and Market position-Related motives	Gain access to new international market; circumvent barriers to entering international markets posed by legal regulatory and/or political factors; defend market position in present markets, enhance market position in present market
2. Product-related	Fill gaps in present product line; broaden present product

Motive	line; differentiate or add value to the product
3. Product/market-Related motives	Enter new product/market domains; enter or maintain the option to enter evolving industries whose product offerings may emerge as either substitutes for, or complements to, the firm's product offerings
4. Market structure Modification Related-motives	Reduce potential threat of future competition; raise entry barriers/erect entry barriers; alter the technological base of competition
5. Market entry Timing-related Motives	Accelerate pace of entry into new product-market domains by accelerating pace of R&D; product development; market entry
6. Resource use Efficiency-related Motives	Lower manufacturing costs; lower marketing costs
7. Resource Extension- and risk-reduction motives	Pool resources in light of large outlays required; technological uncertainty, market uncertainty; other uncertainty
8. Skills Enhancement-Related motives	Learning new skills from alliance partners; enhancement of present skills by working with alliance partners

(Adapted from Varadarajan & Cunningham 1995)

Taking all these into account, firms are likely to enter into alliances for one or more of six reasons.

(1) To gain faster access to new technologies or markets;

(2) To gain advantages of scale in R&D;

(3) To access technological expertise located beyond the boundaries of the firms;

(4) To leverage the comparative advantage of each partner;

(5) To increase the firm's openness to its environment and stimulate internal innovation; and

(6) To share the risk of R&D beyond the resources of any one firm

(Summarised from Burger, et al. 1993; Robertson & Gatignon 1998)

The motives above apply to the alliance phenomenon in general. It is exceedingly hard, especially for small firms, to make technological cooperation work. It is therefore crucial to grasp why HTSFs continue to pursue technology alliance. The first motive is bound up with innovation. As Schumpeter (1934) predicted, technological change has become discontinuous and market preferences in new technology are rarely predictable. Post-innovation improvements, necessary for market success, make for additional uncertainty. Because of the high cost and complexity of much new technology development, it would be highly risky for small firms with only limited knowledge. Such firms can benefit from strong links with leading edge customers, who furnish them with effective feedback on market requirements and product performance. Collaboration with other supplying firms, perhaps even with competitors, universities, and government and private research laboratories can enhance small firms' innovation capacity. Forming innovative relationships with other firms produces positive sum gains for small participants in terms of innovation and profits, and helps them deal with technological uncertainty.

The second motive has to do with competitiveness and internationalisation. Porter (1980) argues that industrial structures (affected by their level of concentration and competition, scale economics and other entry barriers, and general levels of technological change) influence the behaviour of the firm. Techno-globalism is an important element in Porter's analysis, in that large companies try to control the world's technology, thus, their technology strategies necessarily have an international focus (Soete 1991). Large firms internationally access and develop technologies through collaboration, and, sometimes in tandem with international scientific efforts, manufacture and market them in a multinational framework. This techno-globalism has created enormous changes in small firms' views on strategic action. For instance, many managers in small firms are forced to adopt geographically expansionist strategy and to seek foreign market opportunities in order to circumvent the increasing number of large international competitors entering their home market and seek foreign market opportunities as well (Zacharakis 1997; Oviatt and McDougall 1994). Small firms, however, tend to lack international experience and knowledge of foreign markets. It is also a very expensive, difficult and time consuming business to establish a global organisation and a significant international competitive presence. In this respect, forming a strategic alliance offers considerable time-saving (Contractor & Lorange 1988). In addition, the advancement of information and data processing technology enables small firms to efficiently communicate with foreign partners, helping them to actively pursue joint research and development projects with them without actually 'being there' (Ace & Preston 1997; Bloodgood, et al. 1996).

The third motive is concerned with organisational learning. Organisational learning became the key management thinking since the 90s.

Organisational learning refers to the process by which the organisational knowledge base, information and memory are shaped, developed and distributed within the individual members of the firm (Tsang 1999). In this globally competitive era, managers are urged to improve their organisation's learning system and to turn new knowledge into core competence (Hamel 1991). However, learning internally or self-sufficiently would be difficult and less effective as firms tend to be organisationally conservative and stick to what they know best, hampering integration of the firm's knowledge base with new ideas (Dodgson 1993). Strategic alliance has several advantages in stimulating and facilitating organisational learning, overcoming organisational tendencies to introspection and parochialism. For instance, strategic alliance provides an opportunity to observe the partner's way of doing things, and thus gain new insight into organisational problems, and can stimulate reconsideration of current practices. This can be an antidote to the 'not-invented-here syndrome' (Comb, et al. 1996). Indeed, alliances provide a shortcut to radical change, by-passing organisational inertia and deadlocks, and bolstering learning.

The motivational reasons listed so far, however, are neither mutually exclusive, distinct nor exhaustive. Several of these ideas present us with analytical difficulties; some overlap or arrive at a broadly similar set of motivating forces for alliance formation. Empirical evidence shows that firms tend to enter an alliance with a multiplicity of interrelated objectives (Hagedoorn 1993). Identifying the relationship between one single motivation and alliance formation is thus meaningless, since theoretical approaches do not map directly on to strategic motives. Further empirical research must identify alliance motivation with a more integrative approach derived from multiple theories; the value of such theories must then be gauged by closely examining alliance governance choice and outcomes. To date, no such empirical studies have been made on high-tech small firms.

Conclusion

In this chapter, technology alliance has been conceptualised according to its definition, aim, form and partner types. The definition of technology alliance used here includes activities where two or more partners contribute differential resources and technological know-how to achieve agreed complementary aims. Technology alliance provides positive sum gains, reduces environmental uncertainty and is flexible compared with its alternatives. The aims of technology alliance may include technological innovation and improvement, part of a strategy to outmanoeuvre large global competitors and enhance organisational learning. To do this, HTSFs form numerous long- vs. short-term, horizontal vs. vertical and focal vs. polycentric relationships. The partner types are ever more diverse, ranging from small local incubating research institutes to large competitors in the same industry. The forms of alliance include written and unwritten or formal and informal agreements. As seen in the literature, collaboration in high-tech industries typically reflect more than just a formal contractual alliance. Beneath most formal strategic alliance lies a sea of informal relationships. Nonetheless, formal strategic alliance plays the critical role in allowing firms to stay abreast of rapidly changing technology development. Variety of sub-characteristics can be identified within formal strategic alliance and they are determined by strategic need and by the level of incentive and control.

A large and growing literature grapples with the technology alliance phenomenon, but limitations are apparent because fundamental features of strategic alliance such as definition, partner type, mode and motivation are not clearly addressed. Based on the clarification of them suggested in this chapter, next chapters will investigate technology alliance activities by Korean HTSFs. Before doing it, general internal and external environment of the telecommunications industry in Korea will be described first. This includes identifying the Korean HTSFs, how they have emerged and been established, what role they play in technological innovation and, lastly, how they have utilised collaboration strategies for technology innovation.

Chapter 3: Telecommunications industry, technological cooperation and high-tech small firms (HTSFs) in South Korea

Introduction

The purpose of this chapter is twofold. First, clarification of several concepts is crucial. The aim of this thesis is to analyse the technology strategy of Korean high-tech small firms' (HTSFs) for the purpose of new technology development and innovation. However, the definitions of the 'technology' and 'new technological development and innovation' vary a lot depending on scholars' research scopes and their own interests. Therefore, it is essential to clarify the definitions that fit to this research scope. On the other hand, although there are various technology strategies for new technology development and innovation, no explicit clarification of it has been made applicable to the managers' practice level. This chapter will show that in-house development and strategic alliance are the major practices of technology strategies. Lastly, in order to make the discussion in this thesis more guided and focused, it is crucial to define the scope of HTSFs, and the boundary of the telecommunications equipment-manufacturing sector as they are the interest of this study.

Second, understanding the Korean telecommunications equipment manufacturing sector in terms of its emergence, market condition, major business areas, and the analysis of its domestic and global competitive advantage, will add value for those who have not paid attention to the Korean telecom industry, which was spotlighted very recently. This part may not directly relate to the core subject of this study, however it will improve the understanding of this study as it investigates underlying internal and external environmental contingency surrounding technology-sourcing decision of Korean HTSFs. The last part of the chapter will examine how Korean HTSFs have utilised the various technology-sourcing methods, including technological cooperation for new product development, by reviewing previous literature mostly from government surveys. Doing so will help to identify how previous surveys may provide relevant clues to the research questions of what makes firms pursue a particular mode of technology development, especially technology alliance; if not, the results of this study will add value to the limitation of the previous literatures. The next section clarifies the key concepts of technological innovation, new technology/product development and technology strategy first.

3.1 The concepts of technology, new product innovation and development and technology strategy

■ Definition of technology

The term "technology" has been defined in various ways: a cultural subsystem centred on the relationship between humans and their environment; a system embodied in people (person-embodied), things (product-embodied) or processes (process-embodied); production methods, theoretical/practical knowledge and techniques (soft technology) and goods, machinery and equipment (hard technology). Firms attempt not only to develop new technology (knowledge, skills and artefacts) *per se*, but also to come up with a commercialiseable product to directly improve their profit margins. Many authors use the term 'technology' and 'product' interchangeably when discussing the high-tech industry, although the former is in fact embedded in the latter. These authors treat a set of ideas, concepts and techniques very much like the marketable physical products found in the manufacturing industries. In line with this, the present study uses the terms 'technology', and 'product' interchangeably.

The present work takes a broad view of new technology or products. Certainly, new technology is assumed to be something new to the firm or to the market. However, most of the new product innovation and development introduced by small firms are imitations (extensions) or modifications of products and services already available from other firms (Tether 2002). From the HTSF's point of view, it is not always desirable to develop a brilliant new product; even new technologies are highly likely to be embedded, combined and interrelated with old and existing ones. For the purposes of this study, the terms new technologies do not necessarily imply that these are new to the relevant market; they may for example be significant improvements on existing technology within a particular enterprise.

■ Technological innovation and new product development

According to the Oslo Manual, which sets out to standardise the process of collecting data on innovation (OECD 1997), technological innovations are defined as significant improvements in business performance as a result of the introduction of technologically new products and/or the implementation of technologically new processes. More specifically, the Manual (OECD 1997) provides the following definitions of technological innovations:

(1) Product innovation: a new product whose performance differs significantly from that of previous products (major innovation) or an existing product whose performance has been enhanced substantially (incremental innovation)

(2) Process innovation: A new or improved production method, either hardware or software, that significantly increases production efficiency, reduces production costs or upgrades the composition of production factors

(3) Innovative firm: a firm that achieves either product innovation or process innovation (or both) during the reference period.

Technological innovation is an economic activity with very special informational and coordination requirements. In line with the work of Teece (1992), this study suggests that HTSFs' technological innovation activities exhibit the following characteristics. First, technological innovation requires access to complementary assets. Access to complementary assets such as marketing, reputation and after-sales support is almost always needed for successful commercialisation. Innovative new technology will not generate value unless it is successfully commercialised. Second, technological innovation depends on fusing scientific, engineering entrepreneurial and management skills with an intimate understanding of user needs. The user often stimulates innovation, suggesting new product concepts, which are then passed back upstream to be developed further. Innovation thus requires considerable vertical interaction and smooth communication flows with timely feedback, redesign, correction and rapid commercialisation. Third, successful technological innovation seldom stands alone, and usually involves various technologies; these tend to be connected to prior development of the same technology or to complementary or facilitative advances in related technologies.

In fact, whether an enterprise is able to take a particular technology further often depends on whether it was involved in the development of the earlier generation. If not, the enterprise in question has to link up with enterprises familiar with that area. In order to achieve technological innovation, a firm often needs tight interdependence, successful interaction and smooth information flows with other organisations.

■ Technology strategy for new product innovation and development

Technology strategy means guiding a firm to assess its existing technological strengths and weaknesses, identifying/selecting emerging technology, acquiring such technology and exploiting it to maximum advantage (Berry & Taggart 1998). Technology audit and business environment analysis are examples of this. A firm with technological capability but without a technology strategy is a bit like a car without a driver. As firms attempt to use technology to create an enduring competitive advantage, by offering new products or a new process, the design, articulation and deployment of technology strategy become increasingly significant to the firm's performance (Zahra 1996). It is apparent that typical competitive advantage factors such as relatively low cost of necessary inputs and efficient production operation cannot be retained over time. Factor value advantage, based on acquiring technological resources, is essential if the firm is to thrive (Sharif 1997). Therefore, many firms strive to integrate a technology strategy into their overall competitive strategy.

The components of technology strategy are multiple. Simple generic technology strategies may include: (1) technology extender (extension of the salvage value of obsolete technologies), (2) technology exploiter (exploiting the use of standardised technologies for growth) (3) technology follower (following through adaptation of advanced technologies) and (4) technology leader (leadership through state-of-the-art technologies) (Sharif 1997). At firm level strategy, technology strategy is about how managers choose the organisational form that best matches the type of innovation they are pursuing through various governance modes. For instance, Chiesa and Manzini's (1998) provide dynamic strategy formulation framework in which firms first carry out an external and internal analysis of their operations, and then match identified characteristics of technology strategy with this analysis to come up with a plan of action. They identify five actions: competence deepening, competence fertilizing, competence destroying, competence complementing and competence refreshing (for further detail on each action, see Chiesa and Manzini (1998)). The following table summarises the technology strategy for each action.

(Table 7) Technology strategy action and acquisition mode

Technology strategy action	Acquisition policy
Competence deepening	Internal R&D
Competence fertilising	Internal R&D
Competence complementing	Licenses, alliances, joint ventures, Acquisitions (creations of internal R&D group to build absorptive capacity)
Competence refreshing	Acquisitions, (venture capital or internal ventures, creation of internal groups to build absorptive capacity)
Competence destroying	

(Adapted from Chiesa & Manzini 1998)

Seen above, several attempts have been made to assist best technology strategy framework in dynamic environment. Yet, how HTSFs in newly industrialised countries approach to formulate technology strategy in dynamic environment and to what extents the above table can be helpful to those firms? This has been the major question of this study. Prior to addressing this issue, it is essential to understand the fundamental feature of these firms and industrial circumstances that they are playing. This will be explained in the next section.

3.2 The general outlook for high-tech small firms (HTSFs) in the Korean telecommunications industry

■ Definition and characteristics of Korean high-tech small firms

Researchers and policy makers have used a variety of criteria to define a small firm, including total worth, relative size within an industry, number of employees, value of products, annual sales or net worth. Nevertheless, the defining characteristics of a small firm are still a matter of controversy. Rather than identifying what is right or wrong, it is more productive to work out what is useful for the purpose of the research. According to the Framework Act on Small and Medium-sized Enterprises in Korea, firms are classified as small and medium-sized enterprises (SMEs) if the number of employees is less than 300. More specifically, article 2 of the framework act classifies SMEs as follows.

(Table 8) Classification of SMEs

Industry	**Small and medium-sized enterprises**		**Small enterprises**
	Employees	Assets	
Manufacturing	300 or fewer	Less than US$7.6m	50 or fewer
Transportation	300 or fewer	No standard	50 or fewer
Construction	300 or fewer	No standard	30 or fewer
Commerce and other service	20 or fewer	No standard	10 or fewer

(Source: Framework act on small and medium-sized enterprises)

Simply put, HTSFs are SMEs doing business in high-tech industries such as biotechnology, computer software/hardware, telecommunication, etc. In this study, HTSFs refer only to venture firms. The policies of different countries reflect varying notions of what a venture firm actually is. In the US, for instance, venture firms are those offering high risks and potentially high returns and are usually funded by venture capital. In the UK, the term venture firm is simply used to describe new businesses, technology-driven companies or high-tech companies. In Korea, venture firms are referred to as small and medium-sized enterprises that satisfy the following standards set by the Korean Venture Business Act.

- *The firm employs more than 10 employees but less than 300 of full-time and permanent employees, excluding part-time employees.*
- *The firm has an annual turnover of less than approximately US$33 million*
- *The firm is established by an individual or group of individuals; it is administered in a personalised way; management is independent and free from outside control in taking major decisions*
- *The firm is not a subsidiary of an established company; ownership is less than 25% by one or more established companies except where investment is provided by public investment corporations or institutional investors*

In addition, applying firms should meet at least one of the following conditions:

•Venture capital companies should possess over 10 percent of the total shares of the company
•R&D spending should be at least 5 percent of total sales
•The commercialised product should be acknowledged by the patent Bureau and account for over 50 percent of total exports and 25 percent of total sales
•The firm should be selected based on the Venture Business Promotion Committee's Criteria on excellence in research and development

Any HTSF is eligible to apply for a venture firm as far as they meet the above criteria. Once successfully registered, they may benefit from various government support programmes. About 7,569 HTSFs are entitled to the status of venture firm. The following table summarises their composition.

(Table 9) The composition of venture firms in 2002

Industry	No. of firms	Ratio (%)
Agricultural and marine products	36	0.4
Mining	2	0.02
Beverages, textiles, printing, timber, etc.	341	4.5
Petrochemicals	613	8.1
Non-metallic manufacturing	492	6.5
Machinery manufacturing	890	11.8
Electrical equipment manufacturing	664	8.8
Communications equipment manufacturing	1,353	17.9
Medical instrument manufacturing	423	5.6
Automobile accessories	155	2.0
Furniture	159	2.1
Aqueduct and gas	12	0.2
Construction	83	1.1
Conveyance and storage	37	0.45
Computer and information processing	1,782	23.5
Software development	323	4.3
Public service	158	2.1
Retail and wholesale service	31	0.4
Total	**7,569**	100

(Source: KSMBA database)

According to the Small and Medium-sized Business Association (SMBA) in Korea, there are total 20,773 firms in the telecommunications industry, of which 20,512 are small and medium-sized enterprises. 4,123 of these are certified as venture firms, as of 2002.

HTSFs possess unique features. They are noted for the small number of hierarchy levels, with the top-management (i.e. the owner) making personalised decisions in general management, including corporate strategy, finance, accounting and human resource management. This reflects top-management's frequent unwillingness to hire and delegate to experienced managers. Thus, implementation of an effective strategy and planning is heavily dependent on an entrepreneurial attitude among the top-management. Greater organisational flexibility means an enhanced capacity to generate effective information and communication flows within the organisation and respond quickly to market stimuli. Firms can reap benefits from simple and adaptable structures and decision-making processes. The advantage of SMEs over large firms is that the formal has greater management flexibility, speedy innovation and entrepreneurship, which underpin a constant search for new opportunities and encourage challenges to the *status quo* (Chen 1997).

Small firms, though, also feature inherent limitations. For instance, many small firms lack the financial and management resources needed to grow larger. Lack of strategic awareness in formal control mechanisms, marketing and general management undermines the success of HTSFs. A recent survey on CEO entrepreneurship by the Korean Small and Medium-sized Business Association (KSMBA) (2001) shows that many top managers of Korean HTSFs are heavily biased towards technical disciplines such as engineering and science, over-emphasise the purely technological side of their business and neglect other key strategic issues. General management and marketing are significant areas of weakness. Top managers' lack of help from internal or external specialists and insufficient business acumen may prevent them from achieving consistent growth and expanding the business. This is why many HTSFs are good at technological innovation but fail to commercialise or capitalise on it.

There are no formal reporting requirements for the majority of small businesses in Korea. Therefore, it is difficult, if not possible, to obtain sufficient and reliable information to measure their economic performance, for instance, to measure the rate of return on capital. Compared to large firms' efforts to strike a balance between the demands of interest groups or shareholders, the majority of HTSFs allow limited participation by these groups. The extent to which they are involved in formal planning or managerial decision process is limited, though unclear. Some authors point out that HTSFs operate within the turbulent environment of the high-tech industry, where conditions change so fast that environmental forecasting becomes meaningless and long range planning is of questionable value (Berry & Taggart 1998). They insist that formal, elaborate strategic management procedures are inappropriate for small firms as they have neither the management nor financial resources to indulge in them. Having this assumption, the strategic planning process of Korean HTSFs may be less systematic than that of large firms. Instead, informal networks, previous experience and intuition play a greater role in the process of decision-making. HTSFs' unsystematic and often non-rational decision-making processes often form the greatest obstacle to faster growth under competitive market conditions.

■Analysis of the telecommunications industry in Korea

Boundary of the telecommunications industry

Telecommunications have made it possible to exchange text, image and voice with virtually anyone in the world by manipulating high-tech communications systems such as the Internet or devices such as the computer, fax, mobile phone, etc. This has made world commerce dramatically more convenient, people can contact one another at far less cost. Telecommunications is a mammoth industry, encompassing companies in three major areas: *hardware manufacture, software design* and *communication service provision.* The sub-industrial sections of the telecommunications industry include all of these business areas, but the precise definition of sub-industrial sections may vary from country to country. The Ministry of Information and Communications (MIC) of Korea divides the telecommunications industry into three sub-sectors: *the telecommunications software industry, telecommunication equipment manufacturing industry* and *telecommunications service industry.* The definition of each sector is summarised below.

(Table 10) Classification of Korean telecommunications industry

	Sub-sector	Business areas	Business contents
Telecommunications indus	Telecommunications-related software	Software design	System software, applications, software, system integration
		Data processing production	DBS
		Data processing	Data processing

try	Telecommunications equipment	Computer mfg.	Mainframe (super, larger, mini-computer), workstation, PC
		Peripheral/component mfg.	Peripherals
		Telecom/broadcasting equipment mfg.	Wire & wireless telecom equipment
	Service	Basic telecom service	Telephone, fax, mobile phone
		Information/telecom service	Database service, VAN, data transmission, voice information

Telecommunications equipment includes a vast range of products enabling communication across the entire globe, from video broadcasting satellites and telephone handsets to fibre-optic transmission cables. *Telecommunications-related software* brings the hardware to life by relaying and receiving data through satellites, telephone switching equipment and optic-optic transmission cables. *Communication services* include running the switches that control the telephone system, providing access to the Internet, and configuring the private networks through which international corporations conduct business.

Korea's telecommunications market

During the last decade, telecommunications services in Korea have expanded from basic telephone services to more advanced services. Presently, Korea's telecommunications industry provides people with two major services. The first is basic telecommunications services, which includes local, long distance and international telephone services, mobile telephone services, Internet services, ISDN services and packet and frame services. The second is broadcasting services, which include CATV services and satellite services. The attributes of each service are summarised below.

(Table 11) Korea's telecommunications service market

♦Basic telecommunications service market

	Providing services
Local, long distance and int'l telephone services	Intelligent Network (IN) service (telephone communication, 080 toll free number, 161 credit card inquiry number, Virtual Private network (VPN), Service Switching Point (SSP), Signal Transfer Point (STP), Service Control Point (SCP), Service Management System (SMS)
Mobile telephone services	Wireless communication service based on CDMA-based digital cellular phone, PCS, International Mobile

	Telecommunications (IMT)
Internet services	Web hosting, Intranet, online content service, Internet fax and phone
ISDN services	Service for exchanging high-speed high-quality voice, data, text and images via single digital connection with the ease and simplicity of a telephone service

♦Broadcasting service market

	Providing services
CATV services	Consisting of Programme Operator (PO), System Operator (SO) and Network Operator (NO), more than 4,000,000 subscribers in 24 regions are enjoying diverse entertainment and educational programmes
Satellite services	Providing digital satellite broadcasting via commercial satellites, Koreasat I and II launched in 1995 and 1996 in preparation for World Cup 2002 and thereafter

These telecommunications markets are made up of 60 large firms providing unique services to the public. However, the rapid pace at which new technologies and services are being introduced has made it increasingly difficult for telecommunications companies to assimilate and adapt to new technologies. Global trends call for telecommunications operators to be able to provide integrated services (voice, image and data), to meet the growing need for personalised information integration, entertainment and telecommunications services appropriate to a varied range of customers. Strategic alliances and mergers and acquisitions (M&As) are expected to increase as joint assimilation and adaptation projects are increasing. Therefore, increasing number of interfirm cooperation will change the market structure significantly in the near future.

A brief history of the Korean telecommunications industry

The Korean economy grew rapidly in the 1970s and 1980s, and Korea's telecommunications sector did too. Major developments in this period included the construction of basic telephone networks and services to meet increasing demand. The establishment of basic telecommunications networks and services was initially driven by the Ministry of Communications, now the Ministry of Information and Communications (MIC), until 1982 when Korea Telecom (KT), the nation's largest network service operator, was founded and took over responsibility for this area. Since the early 90s, Korea's telecommunications industry has undergone significant environmental and technical changes. Among these are the introduction of competition in the telecommunications market, allowance of foreign ownership of telecommunications services and deployment of new networks and services, all within a new legal framework. Competition was first introduced in the market in 1991 when DACOM entered the international telephone market, previously serviced solely by KT. In the mobile phone service market, SK Telecom lost its monopoly in 1994, when Shinsegi Telecom began to provide a mobile phone service using code-division multiple access (CDMA) technology. The introduction of competition was driven by the government in an effort to cope with the rapidly changing business environment and to enhance the competitive edge of domestic operators. The following table summarises the timetable for liberalisation of the Korean telecommunications market.

(Table12) Timetable for liberalisation of the Korean telecommunications market

Dec. 1991	Competition in int'l telephone market-KT and DACOM
Aug 1992	Competition in radio paging market-SK Telecom (nationwide) and 11 local service providers
July 1994	Competition in mobile phone market-SK Telecom and Shinsegi Telecom
March 1995	Competition in long distance telephone market-KT and DACOM
June 1996	27 new service providers licensed across seven service areas, such as PCS, TRS and CT-2
June 1997	10 new service providers licensed in five service areas, such as local/long-distance telephone market
January 1998	Competition in voice resale, Internet phone and international callback services Foreign ownership permitted in both wired and wireless services up to 33 %
January 2001	Foreign ownership permitted in both wire and wireless service up to 49 %

In addition, Korea laid the foundations of a comprehensive communications infrastructure with the capacity to serve as a common network for upcoming telecommunications services. In April 1996, the Information Promotion Committee was established, based on Article VIII of the Basic Act on Informatisation Promotion. The Committee was primarily responsible for establishing, revising, coordinating and evaluating the master plan for informatisation of Korea. The Committee put together the Korea Information Infrastructure (KII) plan, intended to provide a new network foundation that will serve as the core of the information society in the 21st century. The KII construction plan consists of three phases. The first phase (1996-2000) involves laying the foundation for construction of a national information network, with the government making the initial investment. The second phase (2001-2005) is geared towards spreading the use of information networks by encouraging individual and industrial end users. Finally, the third phase (2006-2010) features efforts to construct an advanced information infrastructure and to promote a higher level of information network use, by meshing the national information network with global network.

As a result of concerted efforts by both the government and private sector, Korea became the 10th nation in the world to successfully develop its own electronic switching system, TDX, TDX-1A/1B and TDX-10/10A (all developed from 1986-1996), and the sixth nation to export automatic electronic switching systems. In addition, Korea has successfully developed optical transmission systems at the 155 and 565 Mb/s and 2.5 Gb/s levels (1991-1995) and became the second nation in the world to develop 16/64 MDRAM (1989-1992). Korea has successfully developed TICOM I, II and III (1988-1994), allowing it to secure the necessary computer technology to suit its own needs. At the end of 1995, Korea signed a contract to export USD 870 million worth of Korean CDMA digital systems and handsets to many countries including the US, China, Vietnam and Brazil. Korean global export market share has grown rapidly: the country was ranked 13th in 1985, 11th in 1990 and ninth in 1995 in terms of export. In terms of production, the Korean telecommunications industry was worth USD 49.97 billion at the end of 1995, accounting for 2.86 percent of the world market.

Present status of Korea's telecommunications industry

According to the Annual Telecommunications Industry Report in 2003 by the Ministry of Information and Communications (MIC). The Korean telecommunications industry was ranked 7th for national competitiveness among all OECD member nations. South Korea has 10.38 million Internet users and the highest broadband penetration rate in the world with more than two-third of the country's 15 million homes having access (73 percent of total households). South Korea ranked fourth after Norway, the Netherlands and Hong Kong in a World Survey of Digital Access per household.

(Table 13) Present status of Korean IT industry in the world (as of 2003)

Item	Global Ranking
Broadband Internet household penetration rate	1st
Internet use	4th
Competitiveness of IT industry among OECD nations	7th
IT mobile Internet Index	7th
UN e-government index	15th
On-line stock trading rate	1st

(Source: MIC Annual Telecommunications Industry Report 2003)

The telecommunications industry has made an enormous impact on the Korean economy. During the last seven years, the telecommunications industry has achieved a 19.9 percent annual growth rate, reaching USD180 billion of total production in 2002, up from USD 71.9 billion in 1997.

(Table 14) Korea's telecommunications industry production status

(Unit: USD 100 Billion, %)

Category	1997	1998	1999	2000	2001	2002
Tel' Industry	71.9	83.8	109.4	138.2	143.3	180
Rate of increase	27.1%	16.7%	30.4%	26.3%	3.7%	25.7%

(Source: MIC Annual Telecommunications Industry Report 2003)

This production growth rate is much higher than that of any other Korean industry. The industry grew 3.4 percent last year (2003), higher than the 2.7 percent growth of GDP. The value-added generated by telecommunications accounted for 14.8 percent of total GDP in 2002, up from 8.6 percent in 1997.

(Table 15) Rate of increase in production: major industries

(Average. 1997-2003, %)

	Rate of increase in production	Rate of increase in value-added
Manufacturing	6.1%	4.1%
Chemicals	7.4%	4.6%
Metalwork[sounds strange to me, but may be OK]	3.5%	3.0%
Machinery	4.6%	4.3%
Automobile/Transportation	6.7%	6.0%
Construction	-2.5%	-2.4%
Telecommunications	19.9%	17.7%

(Source: MIC annual survey about the current information & telecommunications industry, 2003)

According the annual survey report of Korean MIC in 2003, Korea's telecommunications exports increased from USD 9.2 billion in 1990 to US$46.4 billion in 2002, while imports increased from US$7.5 billion to US$27.9 billion in 2002, representing a consistent trade surplus. The major export items are memory semiconductors, mobile telephone, LCD, monitors, satellite broadcasting receivers and PCS, while major import items are non-memory semiconductors, large size computers and transmission equipment. Telecommunications equipment has played the leading role in this rapid growth. Some items such as DRAM and LCD have ranked first in terms of global market share. The major export markets are the US, Japan, Hong Kong, China and Taiwan.

(Table 16) Korean telecommunications industry imports/exports

(Unit US$100million)

	1997	1998	1999	2000	2001	2002
Export	313	305	400	512	384	464
Import	219	183	265	355	279	296
Balance	94	122	134	157	106	168

(Source: MIC annual survey about the current information & telecommunications industry, 2003)

The telecommunications industry is the engine of Korea's economic growth, accounting for 11.2 percent of all the value-added production in the GDP in 1999, 13 percent in 2000, 12.9 percent in 2001 and 14.9 percent in 2002. According to the annual report of Korean MIC in 2003, over the next year, industry growth will be fuelled by introduction of the IMT-2000 service, wireless Internet services and an expanded digital broadcasting service, coupled with increased domestic demand for peripherals and components. At the same time, the introduction of new IT services around the world, increased demand for related equipment and appliances, and emerging markets in developing nations will mean more export opportunities for Korea. The real contribution of the telecom industry to Korea's economic growth rose from 38.3 percent in 1999 to 50.4 percent in 2000, clearly demonstrating its importance to the Korean economy. Today, the industry's share of GDP is over 16 percent. The real growth rate is expected to be double the GDP growth rate, and its contribution to real economic growth is forecast at around 30 percent over the next 5 years.

(Table 17) Value added: the IT industry's contribution to Korean GDP (2000-2005)

(Unit US$100billion, %)

	2000	2001	2002
IT production	138.2	143.3	180.0
Growth rate	26.3%	3.7%	25.7%
Value added contributed by IT (A)	64.9	66.9	84.2
Growth rate	26.0%	3.2%	25.9%
Current GDP (B)	497.1	519.0	565.8
Growth rate	8.1%	4.4%	9.0%
Contribution (A/B)	13.0%	12.9%	14.9%

(Source: MIC Annual Telecommunications Industry Report 2003)

From the global perspective, the Korean telecommunications industry accounts for 6.0 percent of global market share in terms of production in 2002, a 4.2 percent increase from 1999. The telecommunications equipment manufacturing industry, in particular, accounts for 11.1 percent of total global market share.

(Figure 18) Korean telecommunications industry: global market share

(Total production, %)

	1999	2002
Telecommunication service sector	2.5	3.5
Telecommunication software sector	0.8	2.5
Telecommunication equipment manufacturing sector	7.9	11.1
Industry total	4.2	6.0

(Source: MIC Annual Telecommunications Industry Report 2003)

The telecommunications industry's global status helped it attract a great deal of foreign inward investment, totalling USD127 million during the period 1997-2002.

(Table 19) Foreign investment in Korean telecommunication industry 1998-2002

(Unit: USD100 million, %)

		1998	1999	2000	2001	2002	Total
Industry total		8.853	15.542	15.217	11.292	9.101	60.005
Telecom-	**Manufacturing**	1.365	1.112	1.865	1.603	403	6.348

munication industry	Service	622	984	430	3.260	124	5.420
	Software	32	199	449	164	103	947
	Total	2.019	2.295	2.744	5.027	630	12.715
% of IT foreign investment in total foreign investment		22.8%	14.8%	17.5%	42.3%	6.9%	21.2%

(Source: MIC Annual Telecommunications Industry Report 2003)

Lastly, the telecommunications industry has made a tremendous impact on employment. According to the official report produced by Korean Information Strategy Development Institute in 2003, of a total of 500,000 new jobs created over the past 5 years, about 200,000 were attributed to the telecommunications industry. The average wage rate is 20 percent higher than in other industries. In 2002, the number of people working in the telecommunications industry reached over 1,214,000 or 5.6 percent of the entire workforce. This represents a significant increase on the 4.2 percent recorded in 1995. Whereas employment in all other industries has risen 5.1 percent on average each year since 1995, employment in the telecommunications industry has risen 19.1 percent during the same period. The rise has been fuelled by the increasing need for highly trained professionals and managers who possess expertise in high technology. In the telecommunications industry, the software sector is creating most jobs, increasing employment at an average annual rate of 14.7 percent since 1998. Nevertheless, the IT equipment and components sector accounts for more than 60 percent of total IT employment.

(Table 20) Employment in telecommunications industry in Korea

(Unit: persons, %)

	1997	1998	1999	2000	2001	2002
Total IT workers (A)	1,009,088	922,706	1,016,440	1,113,512	1,162,616	1,214,613
Computer professionals mid-low level	151,602	145,455	166,607	188,968	218,455	235,769
Computer-related workers	176,115	176,085	190,007	204,302	205,463	209,523
Engineers	152,344	131,987	147,804	164,617	175,573	188,336
Production/ operations	450,337	385,195	417,066	449,075	461,416	473,268
Other	78,690	83,985	94,955	106,550	101,740	107,717
Total workers in	21,106	19,994	20,281	21,060	21,362	21,552,841

all industries (B)						
Percentage of IT workers (A/B)	4.8%	4.6%	5.0%	5.3%	5.4%	5.6%

(Source: The Status of Labour market in Korean IT Industry" (2003), Korean Information strategy Development institute)

■ Distinctive features of the Korean telecommunications equipment manufacturing sector

Simply put, the telecommunications equipment manufacturing sector concentrates on producing devices that transmit or exchange data, sound, voice or video images at anywhere and anytime. It is divided into three sub-categories: information equipment manufacturing, communications equipment manufacturing and components manufacturing. Information equipment manufacturing primarily covers PCs and monitors of all types. Communications equipment manufacturing includes wire (cable) communications equipment (terminal devices, transit exchange, apparatus for line telephones or line telegraphy, communication-related household electrical appliances, etc.) and wireless communications equipment (mobile phone handsets, signal reception apparatus, optical transmitters, transceivers, apparatus for transmitting radio-broadcasts, satellite systems, medical communication systems, etc). Components manufacturing includes software, semiconductors, fibre optic materials, insulated wire and cable and accessories that make the communications equipment function properly.

The telecommunications equipment manufacturing sector is of particular interest to the present study. It is larger and more important than the other two sub-telecommunications industries (the telecommunications services and software industries); it accounts for 67 percent of the production, 65 percent of the domestic consumption, 95 percent of exports and 99 percent of imports of the entire telecommunications industry in Korea. The telecommunications equipment manufacturing sector is highly knowledge-intensive. Spending on R&D in the sector has increased at an average annual rate of over 26 percent from 1993 to 2000, far higher than the 14.8 percent recorded for the overall science and technology sector and the 8.8 percent for non-IT areas. It accounted for over 50 percent of total R&D expenditure in science and technology in 2001 in Korea. The telecommunications equipment industry is one of the most rapidly globalising industries in the world. Trade in telecommunications equipment among the OECD countries in the 1990s grew at an annual rate of 7.6 percent (OECD 2002b). FDI in the industry reached 5.03 billion USD in 2001. This FDI inflow accounted for 42.3 percent of FDI in all Korean industries; 30.2 percent of it went into the telecommunication equipment manufacturing sector.

The global telecommunication equipment manufacturing market has been generally sluggish since 2001 due to a slump in the PC market, the economic downturn and reduced IT investment in the global market. IT equipment and semiconductor exports in Korea have slackened as a result. Nevertheless, strong demand for mobile handsets and semiconductors in domestic and foreign markets boosted production and exports, so the total production of telecommunication equipment in 2003 is expected to record a 30.5 year-on increase and rise at a stable rate of 12 percent to 2007. Following is a brief summary of business, production and export trends for each telecommunication equipment manufacturing sub-sector.

Communications equipment manufacturing sector

Since 2001, sales of transmission equipment have increased, led by the growth in optical transmitters coupled with continuing growth in mobile handsets. Total exports reached USD 226.8 billion in 2002. In the domestic market, growth was driven by the construction of the high-speed subscriber network and increased demand for mobile Internet equipment. Increased sales of mobile handsets in Korea and overseas also pushed up production. Until 2007, the production of communications equipment is forecast to rise an average of 11.2 percent each year due to increased exports of mobile handsets, upgrading of networks to accommodate rising usage of broadband services, and the introduction of the CDMA 2000 and IMT-2000 services. In 2001, exports rose another 25.6 percent to USD 10.4 billion, and are expected to grow at an average annual rate of 12.5 percent until 2007.

Of total communications equipment exports, those of mobile handsets rose to account for 66.6 percent in 2000 and 71.3 percent in 2002. Mobile handsets have become a flagship export product, but this subjects the industry to the risks associated with excessive dependence on a single item.

Since 2000, mobile handset production in Korea has become more sensitive to overseas demand than domestic demand. The production volume declined 13.3 percent to 12 trillion Korean Won, with the mobile subscriber base reaching saturation and elimination of the handset purchase subsidy in Korea. However, with the explosive growth in handset exports, production in 2002 grew 10 percent to 17.5 trillion won. In future, 13.8 percent annual export growth and the introduction of the IMT-2000 service should help push the production volume of mobile handsets to a 9.2 percent annual average.

Korean mobile handset exports were worth USD 7 billion in 2002, a 26.7 percent increase on 2001. In 2002, exports are forecast to rise 25.5 percent to USD 8.7 billion. This strong growth is due to the proliferation of the CDMA standard throughout the US and the strong performance of Korean handsets in existing CDMA markets and in European GSM markets. Exports are also being fuelled by the expansion of the Chinese CDMA network, while exports of top-end handsets such as those featuring colour screens and attached cameras are increasing profitable. Furthermore, Korean handset makers are going all out to bolster their international marketing and are aggressively seeking to increase their global exposure in anticipation of market saturation in Korea.

Information equipment manufacturing sector

This sector mainly produces monitors and communication-related PCs. The information equipment production volume in 2001 dropped 11.9 percent year-on-year to 18.3 trillion Korean Won. The sluggish domestic PC market caused demand for peripherals including printers, soundcards and graphic cards to contract. In the global market, demand for optical disk drives and desktop PCs fell. In 2002, production of LCD monitors rose 26.7 percent through August despite the downturn in the global PC market, keeping production of information equipment above 24 trillion Korean Won. Because demand in Korea has been stimulated by government IT promotion policies and increased Internet penetration, coupled with expected export growth in notebook PCs, LCD monitors, HDDS and optical disc drivers, information equipment production are projected to rise 10.6 percent on average every year to 2007. However, the share of monitors, which currently account for the bulk of information equipment production, is expected to decline as overseas production increases. In place of monitor, production of PCs, optical disk drivers and HDDs will account for greater share of production.

In the global monitor market, demand for CRT monitors seems to be declining after peaking in 1999, and is expected to fall at an average rate of 10 percent until 2007. Demand for LCD monitors is however quickly making up for this. These are projected to record robust annual growth of 50 percent on average and surpass CRTs by the end of 2007. Price decline is the main driver of growth, with prices falling 13 percent annually. CRT exports have also declined sharply since 2002, but strong growth in LCD exports pushed monitor exports up 30.8 percent to USD 2.8 billion. Many Korean firms are expanding their production facility lines to countries such as China and Malaysia with low labour costs in an attempt to increase profitability. Total exports of monitors are expected to increase 10.9 percent a year on average until 2007.

The global PC market has clearly been hit by the contraction in the desktop PC market over the last few years. However, demand is expected to increase due to higher demand for notebook PCs for mobility, an increasing need to upgrade pre-Y2K PCs, and accelerating migration to Window XP and Pentium IV chips this year. For the next five years, Korean PC production is expected to rise at a modest rate of 10 percent annually due to stagnating demand in the US, EU and Japan. PC exports have been sluggish since 2000, hurt by the slowdown in IT investment in the major export markets. Saturation in the US, EU and Japan will continue to hamper export growth. The leverage in the PC market will no longer drive consumer demand upward as in the past. Nevertheless, PC exports are expected to rise 17.6 percent a year, reaching USD 3.6 billion by 2007 because of the new demand for PCs as home entertainment centres and the growth of the Chinese market.

Components manufacturing sector

Components production in Korea recorded a sharp decline in 2001, with weak demand for PCs pushing the global semiconductor market into recession and fierce competition between Korean and Taiwanese makers forcing LCD prices down. The production of semiconductors and LCDs, two flagship export products in Korea, fell year-on-year 5.1 percent and 2 percent respectively, resulting in a 5.1 percent year-on-year decline in components production to USD 55.9 million. In 2003, components production is expected to increase 34.8 percent due to price hikes for DRAM and TFT-LCDs and the strong performance of Korean DRAM manufacturers, whose global market share exceeded 50 percent for the first time. Also, wider acceptance of digital TVs and the emergence of the information appliance market will push component production up at an average rate of 12.1 percent until 2007. Declining market conditions in 2001 resulted in a 40.4 percent drop in exports to USD 19.4 billion, due to the weakness of the US market, which accounts for 22 percent of Korean exports. Despite concerns about continued sluggishness, exports increased 21 percent in 2002 due to quick recovery of the DRAM export market. Exports are expected to rise at an average annual rate of 18.6 percent until 2007.

3.3 The competitive advantage of the Korean telecommunications equipment manufacturing industry

Drawing on Porter's diamond model, this section seeks to analyse the competitive advantage of the Korean telecommunications industry in the global market. However, it is not the aim of this study to examine the explanatory power of Porter's model. Instead, this section provides a holistic review of the industry in terms of its structure, strengths and weaknesses, so that readers may grasp its profit potential and identify factors that might dent the industry's competitive edge. Porter's (1989) diamond model was designed to systematise the notion that an industry's competitive advantage is shaped by four home environmental factors (factor conditions, demand conditions and related/supporting industry conditions, firm strategy/structure and rivalry conditions). In addition, a government/chance factor is included: this influences the functioning of the four major determinants. The next section reviews the present competitive advantage of the Korean telecommunications industry in light of the Porter's five determinants.

■ Factor conditions

The most important factors in production include physical resources, human resources, knowledge resources, capital resources and infrastructure.

Porter (1989) argues that gaining competitive advantage through these factors depends on either these factors being low-cost or highly qualified and well established as well as on their being deployed effectively and efficiently. In addition, these production factors should not be easily duplicated by others.

According to the publication of the Korean Information Strategy Development Institute (2003), demand for IT human resources has steadily increased and the number of workers engaged in IT professions reached 1,215,000 in 2002, or 5.6 percent of the total national workforce, and is expected to reach 1,505,000 by 2007. This is dramatic growth. At the end of 2000 the total number of workers in the IT industry stood at approximately 494,825, 2.3 percent of the total national workforce. On average, the IT workforce grew 9.6 percent annually from 1998 to 2002, while the total number of workers in the economy increased only 3.8 percent during the same period. However, the number of IT manufacturing and assembly line workers is consistently decreasing due to the high labour costs in Korea and transferral of such jobs to neighbouring countries such as China. The low labour cost advantage, the key source of competitive advantage for many Korean industries until the early 1990s, is diminishing. Instead, the demand for workers in knowledge intensive areas such as product/software design and research and development and for qualified employees specialised in computer engineering, programming and IT management has increased. The supply of qualified employees has been consistent; the higher wage rate in the industry (16 percent higher than the national average) and the future potential of the industry have motivated many people to enter the job market. In addition, the government has invested massively to train qualified IT employees, more in fact than some developed countries such as the UK and Germany. Nevertheless, the supply of qualified experts in such knowledge intensive areas is failing to meet industry expectations. Industry experts anticipate that the shortage of such qualified professional will reach 75,000 by 2006.

Although the rate of telephone line and PC supply is 18th among OECD nations, Korea ranks third for spending on communications infrastructure. As a result, Korea ranks 1st and 3rd among OECD nations for higher speed broadband and mobile communication infrastructure respectively. Many developed nations such as the US, UK and Germany are trying to benchmark the Korean Internet and mobile communications infrastructure. On the other hand, private sector capital investment in many small high-tech firms is increasing, boosting the establishment of new startups. Korea has the third highest level of venture capital investment as a share of GDP among OECD countries. More than 40 percent of total venture capital went into the IT sector, placing Korea 8th among the OECD nations. Although venture capital investment increased, many companies requiring funding still seem to have limited access to it: Korea ranked 16th in terms of accessibility to venture capital. Nevertheless, as we interpret all these figures, one thing is clear: the Korean IT industry is growing and new startups are proliferating based on favourable factor conditions in Korean IT industry.

■ Home demand conditions

Examples of home demand conditions include consumer composition, industry size, the pattern of the industry's growth and the internationalisation of home demand, all of which influence an industry's competitive advantage over rivals in other countries. Consumer composition represents the nature of the homebuyers in terms of their proximity to or quality demanding to the products introduced by the firm. It also denotes the level of domestic market share of domestic firms. Industry size and growth pattern centre on economies of scale, the growing number of independent buyers and the growth rate of the home market. Internationalisation of home demand refers to a mechanism by which a nation's domestic demand internationalises and pulls its products and services abroad because of, for instance, multinational buyers, the mobility of the product or political/historical ties.

Korean customers tend to be highly sophisticated, idiosyncratic and high-end oriented in selecting high-tech embedded products. For instance, the existing customers' rate of exchanging mobile handsets and peripheral items is the 2nd highest after Norway. Customers consistently demand new services such as camera-phones, standalone games, Internet connection, messaging services, on-line banking, etc, both from handset equipment manufacturers and communication service providers. Recent research of the Ministry of Information & Telecommunication (2003) shows, that Korean customers switch to new mobile services or equipment if their current ones fail to meet the latest communications service standards, changing their mobile phones [if this is correct] every 28 months on average. Peripheral design and peripheral functions (music downloading, MP3, bell sounds, data storage and mobile multimedia) are also important criteria in selecting new service providers. The Korean telecommunications industry is faced with fickle customers demanding higher service standards and exceptional product quality in the domestic market. This puts special pressure on firms to upgrade their product quality and service, helping the Korean IT industry globally competitive.

Rapid growth and an expanding home market provide a dynamic advantage to domestic firms, mainly because they foster investment opportunities, economies of scale and first mover advantage. As of 2002, 67.7 percent of the Korean population subscribe either to the Internet or mobile communications services, and this is expected to rise to 75 percent by 2005. The Korean telecommunications industry has achieved solid growth since 1990. Production has grown tenfold over the past decade, unaffected even by the financial crisis in the late 1990s. Domestic sales of IT products have also shown remarkable growth, from 13.9 trillion Korean Won in 1990 to 139.3 trillion Korean Won in 2001. These growth rates will however be much smaller in the near future: the e-business fever that underlay the fast expansion of the Internet-related hardware market has lost steam since the global recession in 2001. In addition, the number of new mobile phone subscribers has dropped since the global recession as the government stopped paying the subscription fee for new customers (mobile phones are the Korean IT industry's main product). Nevertheless, it is expected that the strong growth in data communications, due to an increase in capital expenditure on communication equipment and preparation for the IMT-2000 service launch, will sustain strong and consistent growth until 2007.

The telecommunications industry is more globalised than any other Korean industry. As stated earlier, since 1997, foreign direct investment (FDI) in the telecommunications industry has increased significantly. 43.3 percent of the FDI in Korean industries went into the IT sector. Sales by foreign producers of communications equipment, servers and package software are continuing to rise. The US, Japan and East Asian countries (Hong Kong, Taiwan and China) are the major buyers of Korean IT products. Korea is the 5th major IT exporting country after the US, Japan, Germany and the UK, indicating that Korean IT products are well recognised in the global market. In particular, Korean CDMA mobile phones make up 70 percent of the global market. Major Korean IT companies such as Samsung and LG have been spectacularly successful in the global market. However, the export items dominating the global market are limited to memory chips, mobile handsets and LCD displays. It is therefore necessary to diversify the composition of the export market and export items as countries such as China and Taiwan have emerged as major competitors in these items.

■ Firm strategy/structure and rivalry

Porter (1989) contends that there exist distinct national patterns in terms of goals, typical strategies and ways of organising corporations due to unique political, religious, educational and social norms. Together, these influence the country's management practices and preferred generic strategies. The point is that there should be a good fit between the sources of competitive advantage (i.e. strategy, structure) and the practices of the particular industry. When these fit, the industry gains a competitive advantage. Rivalry is also a highly important determinant of the competitiveness of an industry. The existence of intense domestic rivalry encourages firms to move away from reliance on basic factor advantages since local competition automatically cancels out such advantages, which stem from simply being in that particular industry.

From the beginning of the privatisation of the telecommunication service market in the 1990s, the Korean government has consistently promoted market competition and private investment in the industry in response to global trends toward deregulation and liberalisation. As a result, competition in the broadband and telecommunication service markets is the most severe, and attracts the greatest amount of private investment. In this competitive environment, with limited government aid apart from technological and financial support systems, promoting economic cooperation with other nations, which facilitates technology co-development, the establishment of a framework of intellectual property rights and the building of a global information society.

International cooperation has been the major policy issue among East Asian countries. By revitalising economic cooperation based on mutual benefit, win-win conditions and similar geographical/historical conditions, East Asian countries are trying to establish a competitive position in the global telecommunication market vis-à-vis mammoth economic blocs such as the EU and NAFTA. Korea is playing a leading role in this area. As the originator of the CDMA, Korea is for example involved in the CDMA test belt project and the CDMA coalition in East Asia. In addition, Korea has been a leading player in the establishment of the APEC (Asian-Pacific Economic Cooperation) IT infrastructure that connects the US, Japan and Singapore via a high-speed information network; Korea first advocated the establishment of APII (Asian-Pacific Information Infrastructure). Moreover, Korea has played a significant role in launching the Trans-Eurasia Information Network Project, a high-speed pilot network connecting Asia and Europe launched in 2001.

Korea is trying to lead the East Asian market through the international cooperation. Marketing capability and promotion of the design and brand image of IT products is important in sustaining the competitive advantage of a firm. The marketing capability of Korean IT firms is much weaker than that of their major foreign competitors in the US and Western Europe. This may be due to industrial tradition: many complacent, government-run IT suppliers, operating within a protected and monopolised market system, may not perceive the necessity for an advanced marketing strategy. Though technological capability is important for building sound products, it cannot in itself turn Korean IT firms into viable economic actors in an era of open markets and global product standardisation. If the bulk of Korean firms are to enjoy a sustainable competitive advantage, they must mark themselves out from their top-level competitors in design, marketing and service, the key factors in extending sales and market share.

Sound competition between rivals in the domestic market becomes a source of competitive advantage in the long run. Such competition should therefore be more induced. The Korean telecommunications market, despite the presence of 18,332 firms, has been led by two major conglomerates, particularly in equipment design and manufacturing: Samsung and LG. Together, these make up 75 percent of the Korean telecommunications equipment market, and their market share continues to increase. Although the market is dominated by these two, there are no signs of collusion between them. Competition between them is in fact fierce. Samsung leads the market in CDMA, GSM, TDMA, semiconductors and LCD as well as product design and marketing capability. However, LG has made dramatic progress in the same fields over the past 2 years, and is now ranked 5th in the global telecommunications market as a result of a successful high-end and customized product strategy.

The dominant Korean conglomerates have been run in accordance with a corporate governance system based on family ownership and management. The organizational structure and decision-making process thus tend to be steered by the owners' interests. This governance structure undermines the competitiveness of the firm as well as damaging the property rights of shareholders and creditors. For instance, the owner's personal ambition and the lack of properly functioning internal corporate governance have prevented these firms from concentrating on core competences, strengthening cooperative relationships with small firms and maximizing corporate and shareholder value. Worst of all, wrongdoing or misjudgement by the owners under this system incurred no penalties.

Since the financial crisis in 1997-1998, however, raising corporate governance standards became the key issue for the Korean economy. Outside directors became mandatory under law and audit and nomination committees were introduced to improve the corporate governance structure. With the economic recovery, however, complacency crept in; the typical family-based governance system remains prevalent among many leading Korean *chaebols.* However, major players in the telecommunications industry have been steadily but successfully restructuring their governance structure. International magazines recently designated Korea Telecom (KT), a newly privatised firm, Samsung and LG as the companies with the most transparent corporate governance structures in Korea. This transparency is helping them achieve global success and attract foreign capital. These three firms are models of best practice in Korea; they demonstrate that without transparency and accountability in corporate governance, the firm and the industry as a whole cannot achieve competitive advantage in the global market.

■ Related and supporting industry

Having a competitive domestic supporting industry (i.e. supplying industry or related industry) is preferable to relying on qualified foreign partners. The major benefit here originates in the process of innovation, which is facilitated by a free and open information flow in a geographically and culturally proximate environment. Similarly, the presence of a competitive related and complementary industry that shares common technologies, inputs and distribution channels may be also beneficial: industrial similarity may foster technological spillovers and joint research projects, dissemination of business information, new business opportunities and network externalities. Since the related industries complement each other, the success of one firm creates demand for the complementary products or services of the others.

To ensure technological innovation and sustained organizational performance in the liberalized telecommunications market, many small and large telecom-related firms consider the interconnections and close links between them to be most crucial to their competitive strategy. Interdependence among IT producers and users, through vertical/horizontal links and integration, is also spreading quickly and generates mutual benefits; telecom service firms are closely related to the telecom equipment manufacturers, and the stronger telecom service firms must be propped up by the powerful telecom equipment firms.

Many Korean conglomerates try to help their promising small firms to secure a steady supply of technological ideas by incubating them with capital investment. Hyundai, one of the largest Korean conglomerates, has built several venture towns in major Korean cities to assist 90 small supplying firms, and plans to invest US$514 million over the next two years. Samsung Electronics has been nurturing high-tech spin-offs and investing 10 percent of total R&D investment in its promising small supplying firms. LG has made equity investment in 80 high-tech venture firms in the internet and telecoms sectors and has provided legal, accounting and strategy consulting. The major strengths of these business groups are the long-term relationships and continuing information exchange that occur between them, thus making long-term and perhaps collaborative research more acceptable. In addition, the increasing number of technological cooperation agreements and mergers and acquisitions (M&As) among small firms demonstrates the importance of establishing and securing stable linkage with supplying and related counterparts. Tight-knit relations among various sub-sector players are the defining feature of the Korean telecommunications industry and give it its competitive edge.

Government/change factor

Lastly, the role of the government is indirect but highly significant: it influences the four major determinants of a domestic industry's competitive advantage. Porter (1989) argues that the proper role of the government is to strengthen the underlying determinants of competitive advantage. Successful government policies are those that create and stimulate an environment in which firms can attain and enhance competitive advantage. Chance refers to events that have little to do with the four determinants or the government's role and that lie outside the control of the firm and the government. Examples are abrupt shifts of foreign currency, technological discontinuities, oil shocks, wars, natural calamities, etc. Chance may generate forces that reshape the four determinants and affect the competitive position of an industry in the global market. Porter argues, however, that the determinants of an industry's competitive advantage are not therefore unpredictable: the four major determinants are most likely to be influential.

Korean government policy on IT features four major goals, intended to help Korea become one of the top ten nations in the world in terms of information infrastructure and industry. The first is to implement the national information policy, which aims to promote the knowledge-based economy essential to sustainable economic growth. The Master Plan for the Information Society and CYBER KOREA 21 policies, introduced in 1996 and 1999 respectively are examples. These programmes include nationwide ADSL and fibre optic interconnections, e-government to establish a one-stop civil service and IT education programmes for women and elderly people. The second goal is to implement policies to promote the IT industry and enhance its global competitiveness. These include a 5 Year Plan for development of information technology through investment in 6 major areas, deregulation and tax reduction for high-tech start-ups and venture capital revitalisation. The third goal is to lay down regulations to increase market competition in the telecommunications sector. Now, new entrants can voluntarily file applications for starting telecom businesses. The government has also abolished the limitation on individual ownership and permitted non-telecom service operators to carry out M&As. The role of the Korean Communications Commission has been strengthened to ensure transparent corporate governance and fair competition in the market. The fourth goal is to attract foreign investment. Tax reductions, of up to 100 percent of the national rate for 10 years, are now in effect for high tech businesses and foreign investment zones. In addition, the government is introducing rent reductions for foreign companies in industrial complexes, 25 national industrial complexes and foreign investment zones. M&A activities (hostile takeovers) are allowed. The ceiling on foreign ownership is 49 percent or has been abolished, depending on the industry. It is very hard to evaluate the effects of these promotional activities. In any event, many respected foreign newspapers such as the Financial Times and the New York Times have heralded these policies as a remarkable achievement.

■Implications of the industry analysis

The five major factors influencing the competitiveness of an industry teach us several things. The Korean telecommunications industry has grown remarkably over the past 5 years. The Korean IT industry ranked 6th in the OECD league table for competitiveness in 2002; it is relatively strong and competitive in the global market. Its competitive advantage is attributable to the open domestic market and highly demanding customers. Domestic firms far less engage in anti-competitive practices such as market sharing, price arrangement or allocation of customers. The government has taken firm steps to ensure fair prices and fair trading among dominant firms to safeguard customers' interests, while customers consistently call for a wider range of products and services based on affordable prices, and transparency in customer contracts and dispute settlement.

Effective competition in the internal market and high level of customer demand ultimately improves the positions of both customers and firms. The telecommunications industry has taken the lead in improving corporate governance, thus boosting economic transparency and increasing the confidence of foreign investors. Cooperation between industry, universities and institutes and the nurturing of promising startups and spinoffs by major conglomerates are getting more active in these days. Despite the fact that much remains to be done to make the industry globally competitive, the present status of Korea's telecommunications industry is the result of the continuous efforts of industry, research institutes and the government.

A consensus has formed that the telecommunications industry is central to the dynamic growth of the Korean economy. However, the best way to make the industry globally competitive is still subject to debate. For instance, Korea's world-class competitive advantage and technological leadership is limited to semiconductors, mobile phones and LCD. The China is fiercely closing the technological gap with Korea in these product items. Korea should be gaining technological edge in non-semiconductors, transmission equipment and large size computers which are highly value added and complex IT products dominated by US and Japan.

There is no doubt that the telecommunications industry will continue to be the main contributor to the Korean economy. Nevertheless, the industry's future success depends on tackling the aforementioned weaknesses. Newspapers reports (i.e., Lee 2004) have recently appeared claiming that the future of the Korean telecommunications industry is at risk and hollowed despite its current success and seemingly to be catching up with the leading IT nations, the US and Japan. Korea is in fact far behind these competitors in the number of qualified IT experts and engineers and in core technology. Korea still relies on the above three countries for major components; the Koreanisation of Korean IT products was only 55.4 percent in 2000, down from 64.9 percent in 1995. This means 55.4 percent of profits that Korean IT firms earn go to big technology lenders (US and Japan) as fee payment or loyalty.

In sum, the competitive advantage of Korean telecommunications industry is relatively strong, however, it is extremely uncertain how long the Korea will maintain its status due to its weak factor conditions. Ultimately, it is the factor conditions in terms of employment of qualified professional, education systems and R&D investment in technological capability that determine the high-tech industry's global competitive advantage. Unless these conditions are not enhanced, the present global status of Korean IT industry is pretty unstable.

3.4 The status of high-tech small firms (HTSFs) in Korea's telecommunications industry

Korean needs a new paradigm, befitting the new global environment, was needed not only to overcome various recent financial crisis, but to achieve sustainable growth in the 21st century. The government identified three tasks: restructuring economic fundamentals away from large firm-monopoly in capital and the labour market, nurturing knowledge-intensive industrial sectors and promoting entrepreneurship and technological innovation. The government sees HTSFs as one of the means of realising these goals and believes they have a key role to play in the future development of local economies and of the national economy.

The government took "Act on the Promotion and Encouragement of Small and Medium-sized Enterprises (SMEs)" in 1997, which included providing generous technology development funds, subsidising the establishment of new businesses and easing venture capital regulation. Above all, the launch of the KOSDAQ stock market in 1996 helped invigorate many HTSFs. The KOSDAQ stock market (like NASDAQ) was designed to facilitate corporate financing for promising HTSFs and provide opportunities for investors. Firms must meet strict prerequisites to be listed. As of 2002, there are about 20,773 small firms in the telecommunications industry, of which 4,123 are certified by the government as high-tech small venture firms. Of these 4,123 firms, about 3,000 are involved in telecommunications equipment manufacturing. A total of 150 out of 4,878 telecommunications-related venture firms are registered on the KOSDAQ stock market, accounting for 31.4 percent of total KOSDAQ listed firms. 1999-2001 in particular was a period of rapid development for many HTSFs. The collapse of many large firms during the financial turmoil of 1997 also accelerated establishment of independent small businesses run by laid-off workers. As a result, the rate of establishment of HTSFs rose sharply.

The government efforts mainly concentrated on tax relief and capital funding, helping many small firms improve operational profit and buoying the KOSDAQ stock market. The post-2001 period was one of transformation for many Korean HTSFs. The government attempted to rationalise the venture capital market and many improperly run or insolvent HTSFs were restricted from gaining further access to capital until they met strict conditions. Transparent corporate governance and codes of conduct are emphasised in this period. In sum, from 1998 to 2002, the number of venture enterprises multiplied more than 5.5 times, the average number of employees rose 9.5 times and average sales increased 2.8 times.

(Table 21) Growth of high-tech small firms in the Korean telecommunications industry 2000-2002.

	1998	1999	2000	2001	2002
Total no. of small firms	10,203	8,999	,13,825	16,465	20,777
Total no. of small venture firms (A)	9,395	6,949	8,798	11,392	10,182
No. of telecom venture firms (B)	**808**	**2,050**	**4,017**	**5,073**	**4,874**
Telecom venture firms: percentage of total small venture firms (B/A)	**8.6%**	**29,5%**	**45.7%**	**45.0%**	**47.8%**

(Source: Kiun Research 2003)

The table above demonstrates that HTSFs in the telecommunications industry have the majority position among all Korean venture firms (including biotech, pharmaceutical and electronic venture firms), accounting for more than 47.8 percent of the venture enterprises certified by the Korean Small and Medium-sized Business Association (KSMBA). The HTSFs in telecommunications sector have also shown sharp growth in number of employees, average R&D expenditure and average sales size, seen the table below.

(Table 22) The average number of employees and R&D expenditure by Korean telecoms high-tech venture firms (1998-2001)

	1998	1999	2000	2001
Average no. of employees	37.08	37.14	39.11	46.51
Average R&D expenditure (US$ thousands)	4,500	4,400	5,100	12,500
Average sales (US$ thousands)	294.0	316.2	359.7	644.0

(Source: Kiun research 2003)

Venture capitalists played a significant role in nurturing venture firms. Venture capitalists are institutional investors who offer capital to startups or companies in high growth phases through equity investment and extend their management and other support to maximise the return on their investment. The volume of venture capital has risen greatly due to the proliferation of venture capital firms and their efforts to raise investment. Most venture capital investment presently goes to IT venture enterprises as the venture boom in Korea was led by the IT industry. In 2001, investment in the information and communication sectors accounted for 61 percent of all venture capital investment. Leading venture capital firms often cite the professional expertise in the IT industry as the key factor in its competitive edge. Although investment in Internet and on-line ventures remains low in the wake of the dot.com bust, which began in the latter half of 2000, it still makes up a considerable portion of all investments.

The labour market in the telecommunications industry is extremely fluid. The rates of job creation and destruction are much higher in the telecommunications industry than in manufacturing industries. The most intensive period of job creation in the telecommunications industry occurred between 1999 and 2000, a period when optimism in the industry was at its highest. Most jobs were created by small venture firms. In the telecommunications industry, many jobs were eliminated at record high rates at large firms, demonstrating that such firms are apt to move quickly to adjust their payrolls in response to changes in technology or market environment. The relatively lower job destruction rate at small firms may be due to government policies promoting startups, helping prevent their exit from the market. The software industry created the most jobs, increasing employment at an average annual rate of 14.7 percent since 1998. Nevertheless, the IT equipment and components industry still accounts for more than 60 percent of total telecommunications industry employment and these workers are mostly hired by high-tech small firms.

Industry experts attributed remarkable success of high-tech small venture firms during the past five years to a number of factors, but highlighted the government's hands-on approach in developing the country's telecommunications architecture. The government recognised the IT industry as a vital part of the country's future competitiveness. Based on the Master Plan for Information Promotion and e-Korea Vision 2006, the government has created a favourable environment for HTSFs by creating a single regulatory body, subsidising financial capital and lowering tax rates. In 1996, the Korean government transferred policy-making on small and medium-sized Enterprises (SMEs), which had been the task of the Ministry of Commerce, Industry and Energy, to the Small and Medium-sized Business Administration (SMBA), which is the central government agency for small companies. The SMBA initiated seven major promotional and assistance Acts on small firms and raised funds for financial assistance including credit guaranty funds, guaranty for preferred loan for technology innovation, etc. The government invested a total of USD 2.3 billion in HTSFs during 1997 and 2002, mostly subsidising their research and development and initial business establishment. As a result, as of 2003, HTSfs account for 25.7 percent of total production and 27 percent of total exports in the Korean telecommunications industry. The total output of the top 100 HTSFs in 2002 was USD 9.5 billion, a 98 percent increase on 2001. 263,000 workers are engaged in HTSFs in the industry, four times larger than the figure in 1999.

3.5 Technological innovation and technological collaboration of Korean high-tech small firms (HTSFs)

The present study has thus far outlined the expansion of many high-tech small firms in telecommunications in terms of their number and economic contribution. Nevertheless, these factors do not necessarily mean that all of them are technologically capable and competitive in a global perspective. In fact, government policy has prioritised boosting the establishment of new venture businesses and their business activities, rather than on reinforcing their technological strength. As seen in section 3.2, the technological capability of many Korean high-tech small and large firms still lags behind that of the developed nations. This section assesses the technological capability of Korean HTSFs by examining their innovation activities and how they are utilising cooperative methods for such activities.

■ Present status of technology development among Korean high-tech small firms

An industry's R&D intensity level is measured by average R&D spending divided by average sales during a given fiscal year. The telecommunications industry is the most R&D intensive in Korea with an intensity level of 27 percent of intensity, followed by the fashion industry with 24 percent, as of 2001-2002. 60 percent of telecom HTSFs (of a total of 4,878) have their own R&D departments or research institutes, while the remaining 40 percent, mostly relatively small firms with fewer than 10 employees, utilise their manufacturing/production departments for R&D tasks.

The innovation rate of HTSFs (number of new products/technologies introduced divided by total attempts) is 0.34, higher than non HTSFs with 0.28, but less than foreign-owned high tech firms with 0.38. On average, each HTSF possesses 10 technology patents, but only 0.43 are patented in foreign countries of every 8 applications. The majority of HTSFs believe that technological innovation is essential to survive in the market, as the technology life span is only 4.5 years on average.

According to a government survey of 3,772 small and medium-sized firms in seven major manufacturing industries in 2002, 3,260 firms, almost half of them in the telecommunication equipment manufacturing sector, were involved in technology innovation projects during 2000-2001. 82 percent of the firms involved in projects are claimed to succeed in technology innovation. Four types of technological innovation activities are found in the 3,260 innovative HTSFs. Among these, new product and technology innovation accounts for 52.5 percent, upgrading existing technology or products 37.7 percent, and process innovation, including establishing new facilities and restructuring production systems, accounts for 9.8 percent.

(Table 23) Content of innovation projects

	New product /technology innovation	**Improving or modifying existing products/technology**	**Production system development**
1991	40.6%	44.4%	9.0%
2001	52.5%	37.7%	9.8%

(Source: Park & Yoon 2003)

More firms have turned to new product and technology innovation over the last decade. However, only 25.5 percent of all innovative firms patented their technology in the domestic patent office. This suggests that the technology/products developed may lack originality or creativity.

3,260 responding firms point out that a shortage of doctoral-level technical manpower in science and engineering has been a serious industrial problem, holding back the technological development of Korea, and underline that HTSFs suffer most from this shortage. These firms have 88 employees on average, among which about 20.1 percent work in the R&D department.

More than 70 percent of HTSFs state that they have trouble acquiring qualified technicians and engineers, and that the shortage of advanced level researchers in the relevant R&D areas is the key factor obstructing their technology innovation. R&D spending has a major impact on the success of new product development and on innovation.

Insufficient finance is the second most important factor, after the lack of qualified human resources, that hinders HTSFs from achieving consistent R&D investment. Many HTSFs establish various funding portfolios to boost their R&D investment. On average, each HTSFs spends USD 1.7 million on R&D, comprising USD 0.5 million of the firm's own equity capital, USD 0.4 million in government loans, USD 0.8 million from venture capital or equivalent institutions. However, government financial support is less efficient: the government may fail to correctly evaluate the potential of the technology it invests in. The private financial sector, such as angel investment and venture capital should be nurtured as they are specialised in evaluating the growth and technology potential of small firms.

For newly established venture firms, indirect financing through the private financial sector is still a far cry from a relevant and timely bank loan, as private finance institutions apply strict due-diligence investigation rules, demanding credit guarantees and collateral. It has been pointed out that the present indirect financing system tends to favour blue-chip companies that can afford to meet the strict due-diligence requirements. The difficulty of getting sufficient R&D financing drives many newly established firms to resort to importing necessary technologies (i.e. technology purchase or license) because this is the cheapest way of fulfilling such needs. This is 10 times cheaper than in-house technology development. On average, each firm spends USD 209,000 to acquire 1.2 new technologies annually.

In summary, HTSFs are actively engaged in R&D for technological innovation, but they face major challenges because of the shortage of highly skilled labour, lack of innovation in fountainhead technology and insufficient financial capital. Nevertheless, this does not mean that they are less active in R&D than large firms. It is obvious that a firm with larger sales revenue will invest more in R&D spending than a firm with smaller sales revenue. But a recent study shows that the ratio of R&D spending to sales decreases with increasing sales, and that while firms which employ more people have larger

R&D workers, the ratio of R&D manpower to the total number of employees decreases as the number of employees increases (Lee 2000; see table below).

(Table 24) Sales revenues, R&D spending and ratio of R&D spending over sales amount in Korea, 1999-2000 (Unit: US$ mil, %)

	Sales Revenue		**R&D spending**		**Ratio of R&D spending over sales revenue (%)**	
	Small venture firm	Large firm	Small venture firm	Large firm	Small venture firm	Large firm
IT industry	6.7	245.5	0.78	7.3	12.51%	4.09%

(Source: Lee 2000)

Although high-tech small firms' R&D spending is much smaller than that of larger firms, the ratio of R&D spending is much higher for smaller firms than for large firms, indicating that small firms are highly active in R&D for technology innovation. This leads to the conclusion that the government and private sector investors should be more creative, flexible and decentralised in providing financial support in order to facilitate the entrepreneurial activity of high-tech small firms. On the other hand, high-tech small firms must nurture themselves if they are to become dynamic and innovative organisations, of which few are to be found in Korea at the moment. That is, they have to steer away from traditional R&D efforts such as reverse engineering and modification of foreign technology, and strive for leadership in fountainhead technology. Focusing on innovation in fountainhead technology is highly advantageous to small firms that lack a large portfolio of technological competences. However, they have avoided such innovation due to its lower rate of success, prolonged R&D investment requirements and long-term payoff. Nevertheless, astute use of non-internal R&D, such as technological cooperation, enables these firms to overcome such obstacles and utilise their limited resources more efficiently.

■ Technological cooperation among Korean high-tech small firms (HTSFs)

There are few extensive empirical surveys on Korean HTSFs' cooperative activities in the telecommunications industry. A survey of 3,326 Korean small firms in the seven major industries in 2000-2001 found that 1,582 firms are involved in innovation projects, among which 668 firms (42.8 percent) carried out such projects via technological cooperation (Kiun Research 2003). That is, only 20.5 percent out of total of 3,326 responding firms are involved in technology alliance to some extent. Similarly, in a survey of 1,300 manufacturing firms involved in electronic appliance innovation projects, 61 percent (793 firms) relied on in-house development while 33.6 percent (507 firms) relied on technological cooperation with research institutes or their customer firms (Park & Yoon 2003). Technology acquisitions via mergers and acquisitions (M&As) and technology buyout are rare among such firms. Instead, technology acquisition via Acquisitions and Development (A&Ds: acquire R&D departments only and develop them) are becoming popular, as this is less risky and costly than M&As.

These surveys show that the use of technology collaboration is not a popular technology strategy in industries nationwide. In particular, small firms in the telecommunications industry are less likely to choose cooperative methods in their innovation projects than other small firms in industries in machinery, household electronics and biotechnology. However, these surveys found that telecom HTSFs' relationships with universities and research institutes are gradually increasing as they attempt to make up for their lack of the technological knowledge necessary for technology innovation.

Conclusion

Under what condition Korean HTSFs choose technology alliance for their new technology development? This was the initial research question of this study. According to the data shown above, numerous high-tech small firms are suffering from the lack of finance-, knowledge- and human-resource, and this may lead the firms to technology sourcing-decision such as choose strategic alliance for new technology development as a method for complementing their deficient resources. However, existing survey data did not confirm that such conditions actually lead them to a particular mode of sourcing-decision because their survey was not designed to investigate this issue with the particular question raised in this study, rather they only gather information regarding the current status of the respondents' technological innovation activities without how they pursue such activities. In fact, no existing survey database provides relevant information or conclusive answer to the question that this study holds.

Interesting finding of the existing data is that, despite vivid R&D activities of the small firms, the use of interfirm collaboration for technology development, particularly as a means of accessing valuable resource and information is much less than the policy makers' and academic researchers' expectation. Industry professionals suggest that globalisation and technological outsourcing are two significant global trends in high-tech industries that Korean HTSFs should bear in mind before they formulate their competitive technology strategy. However, many Korean HTSFs tend to have a mental block against technological cooperation despite its many advantages, such as providing technological information and updated market knowledge on technological and customer trends. Several reasons can be suggested, for instance, the lack of confidence in their firms' technological capabilities, weak intellectual protection and a blurred appropriation regime conditioned by the radical openness of the local market, create a distrustful atmosphere that may hesitate many small firms to pursue technological collaboration. However, all these contingencies remain hypothetical. The need for systematic approach and analysis is required to have a solid answer to why firms choose technology collaboration or vice versa. Therefore, this study will bridge the gap between the hypothetical issues and the need for systematic approach for that. This will developed in the following chapters.

Chapter 4: Literature review on antecedents of the technology sourcing decision

Introduction

Under what conditions are small HTSFs likely to form technology alliances and when are they not likely to commit to technology alliance? As chapter 2 showed, motivational reasons suggest an *ex post* perspective on this question. The limitation of it is that it only deals with why firms are interested in forming alliances; it does not give any insights into what enables firms to choose alliance or not to choose. For analytical purposes, what is needed to answer is *ex ante* prediction to be tested against *ex post* results. Therefore, the primary goal of this chapter is to identify the immediate antecedents of technology alliance formation by small firms in the high-tech industry. Specifically, this study will investigate how firms' behaviour and decision-related contingencies vary across different firms and would act as antecedents of alliance formation.

4.1 Integrative and two stage contingency approach from the strategic management literature

In order to better move to the core theoretical review and prediction, this chapter has to build a fundamental assumption as a premise of this study, so that the study will be able to bring out pivotal elements from extensive literature. First, the main concern of this study is what kinds of information, belief, cognitive evaluation and decision-making procedures the CEO or decision-makers are undertaking for technology-sourcing decision. In order to do this, this study seeks antecedents based on management and economic theories that the top managers are likely to incorporate into their minds and practice upon the technology-sourcing situation. Glimpse of ideas are available from the tale of successful alliance stories and how the decision-maker was able to achieve it. However, such story-telling is insufficient to provide extensive and universally relevant lessons to dominant small firms in general.

How do small firms decide in the technology-sourcing situation? Presumably, better decisions are a consequence of more extensive information collection relevant to the decision. It is obvious that the decision-makers take into account variety of economic, institutional, structural and psychological factors before making the strategic-decision. Different decision-makers have their own logic for identifying the determinants, however. It depends on their intuition, understanding of the market and previous experiences. From the decision- maker's point of view, they may have to wade into a sea of ambiguous, conflicting and contradictory information, confusing what to focus on and what to ignore. Therefore, it will be difficult, if not impossible, to exhaustively enlist all determinants that play as significant antecedents of technology-sourcing decision. In practice, however, researchers find that the portion that the decision-makers are actually adopting for decision-making tends to be relatively small and overlapping (Tyler & Steensma 1995). Based on this ground, this study will focus on identifying parsimonious and commonly-adopted determinants that small firms are likely to adopt for technology-sourcing decision.

Second, although there are numerous theoretical scopes and implications, there is no one dominant and ready-to-use framework appropriate to this study; they are complementary at best for this study's concern. Technology-sourcing decision is, indeed, too dynamic and complicated a phenomenon to be fully covered in a single theoretical lens. In this case, scholars recommend triangulation or the multi-method approach as the best way to understand the phenomenon at hand (Gersony & Peter 1997; Osborn & Hagedoorn 1997). Therefore, this study presumes that understanding of the phenomenon can be enhanced if we entertain several theories and integrate them providing that no theory is fully adequate and they do not fully contradict each other.

However, there is no common guideline or systematic method distinguished on the integrative approach. Influenced by and drawing on the Burgen and Murray (2000) and Jemison (1981)'s approach, this study suggests that the integrative approach is the process that isolates key competing elements of various theories as separate and independent sets of variables, and these are then tested by integrated multivariate analysis, providing further evidence of whether or not the sets of variables explain the phenomenon. To this end, this study relies on strategic management literature. Unlike mathematics or economics, strategic management lacks an agreed, internally consistent and empirically validated body of theories.

However, it employs theoretical concepts drawn mainly from various disciplines such as economics, psychology, ecology and sociology on an *ad hoc* basis (Grant 2002). An integrative approach, consulting with strategic management literature, will provide a powerful and flexible tool to identify and understand the principal considerations that influence not only the technology-sourcing decision but also strategic decision-making in everyday business life.

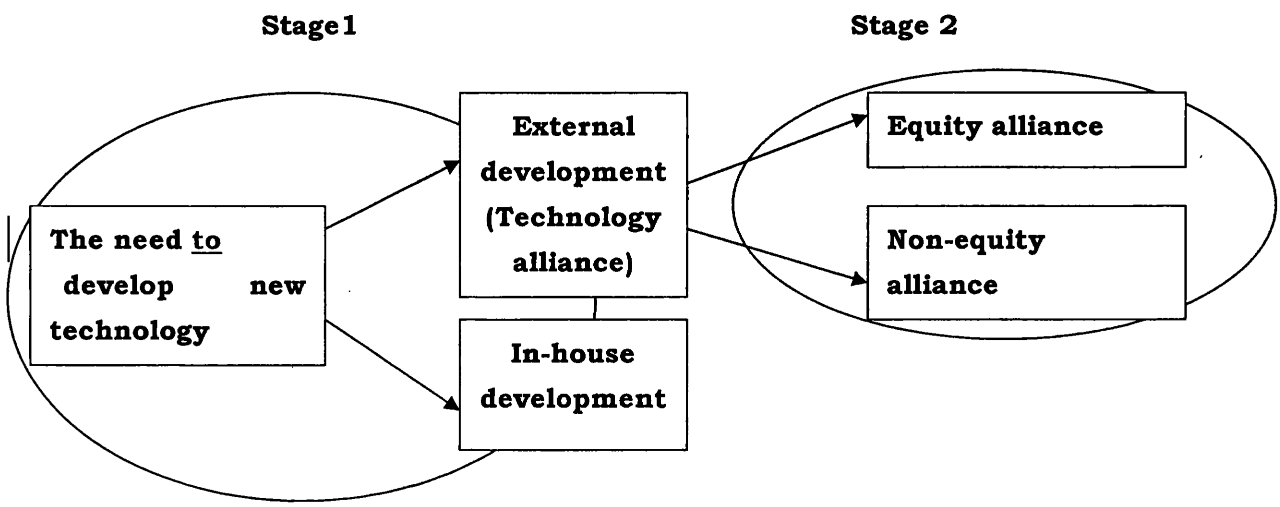
Third, drawing on the normative rational planning model, the implicit assumption of this study is that the decision-making is an analytical and rational process rather than intuitional and emotional. Likewise, the technology-sourcing decision is the structured, pre-planned and logical process in which the decision-makers are capable of seeing condition inducing technology alliance in advance, based on their logical thought and rational insight. Of course, the decision-making is not always the outcome of a highly analytical and rational process; it may emerge from negotiation, bargaining and compromising as individual managers try to adapt to changing external circumstances (Minzberg 1978). Unlike presumption of the rational planning model, decision-makers are not always well-informed and capable of manipulating diverse information simultaneously because they cannot incorporate all information rationally due to cognitive limitation (Schwenk 1995). Often, decision-making may flash through the CEO's mind accidentally or impulsively, so he/she may not need any complicated decision making process.

Nevertheless, at least within the context of the technology-sourcing decision, this study supports normative rationalist assumption. Of course, the normative and rational model is not without limitation. But, studies find that the HTSFs develop technology-sourcing strategy explicitly, consciously and purposefully in advance of the specific decisions to which it applies. Empirical studies find that HTSFs tend to use strategic systematic planning to direct their long-term growth and that this becomes more sophisticated as firms grow (See Berry 1998). Based on the 257 UK HTSFs in the Technology Park, Berry (1998) finds that three quarters of the responding firms believe that systematic strategic planning is essential to the future of their businesses and more than half of them prepare a long-term business plan every year in a formal and explicit way.

Technology-sourcing decisions tend to target firm-specific projects, which have been deliberately pre-planned and designed to meet certain strategic objectives of the organisation in the near future. Thus, it is hard to assume that the process of technology-sourcing decision results from impulsive feelings or intuition of the decision-makers. Above all, the intention of this study is to provide systematic analysis of the phenomenon and useful guidelines for future decision-makers by comparing and evaluating various forms of decision-making. Thus, adopting the normative and rationalist methodological approach is appropriate in this study.

Fourth, having the rationalistic approach, this study will use a decision tree framework to generate a realistic, albeit stylised, portrayal of the process of technology-sourcing decision. Typically one-stage decision tree framework (one step and simultaneous decision procedure) has been widely used in the study of governance choice: for instance, between joint venture vs. wholly-owned (Hennart 1991), licensing vs. acquisition (Atuahene-Gima 1992) and formal vs. informal cooperation (Hagedoorn, et al. 2000). However, they are criticised as less robust and too simplistic from the rationalist perspective; too much significant information is likely to be missing in a simplified model (Vanhaverbeke, et al. 2002; Tallman & Shenkar 1994). The two-stage contingency model denotes that decision-makers of high-tech small firms go through two sequential and contiguous stages (steps) when they make technology-sourcing decisions. This model may be less robust as well, but still generally more applicable than the one stage model. Figure 3 schematises the two-stage contingency model.

(Figure 3) Two-stage contingency model



A comprehensive model of the initial stage would of course include: how the project ideas or proposals emerged into the decision-makers' minds (Chen 1997; Buchowicz 1991); whether the firm pursues the innovation project or not (Veugelers & Cassiman 1999); and what types of R&D activity are more likely to trigger a firm to opt for alliance or in-house development (Chen 1997). This study, however, will not explicitly probe the initial stage since it would be too complicated to identify it in this limited space. Instead, this study premises that HTSFs have at least more than one experience of making technology-sourcing decisions. Given this premise, the first stage of the decision process will be the choice between in-house development vs. technology alliance. In-house development implies "doing the project alone" while technology alliance implies "doing the project together with others".

There exists a variety of available technology-sourcing methods at the management practice level, for instance mergers and acquisitions, technology buy-back, joint venture, R&D contract, licensing, etc., depending on the technology project types, time-span and budget (for further specification, consult Chapter 2, pp.21-23). Therefore, dichotomising the technology sourcing-decision into "doing-it-alone" vs. "together it together with others" sounds very simplistic. However, investigating all possible modes for their own antecedents to choose may be a dire process to research; the analysis will be very complicated unless there are extensively large amounts of data and the several decision modes are lumped together for analytical purposes. Stuart (2000) found that an analysis using a wide variety of alliance modes led to findings similar to an analysis concentrating only on certain types. In fact, in the case of a small firm, available technology-sourcing methods are rather limited compared to those of the larger firms. For instance, technology-sourcing through "mergers and acquisitions" was hardly found among Korean HTSFs. Thus, for the purpose of analytical reason, this study simplifies technology-sourcing decision into the two types mentioned above.

In this study, in-house development, or 'doing-it-alone' means that the firm carries out the project with complete ownership and control, and does not literally mean that the development is done completely independently. Relying on the firm's own R&D department or establishing wholly-owned subsidiaries is a major form of 'doing it alone'. In this study, internalising through mergers and acquisitions of other firms is considered as 'in-house development' because the acquiring firm possesses the whole ownership and control of the acquired company for new technology projects. Technology-buy-back can be part of in-house development as long as two parties exchange the technology for money without shared ownership and control. On the other hand, technology alliance means carrying out the project in cooperation or association with other firms based on shared ownership and control until the technology project is completed. Joint venture is a typical exemplar. This study considers exchanging and trading from the spot market as part of technology alliance (i.e., licensing) as long as it is contract-based and one party should be involved with the other party based on co-ownership and control for a limited time in order to transfer knowledge and management skill in return for money. Licensing or franchising is a typical exemplar. Classifying the mode of technology alliance in the above mentioned way may be rather simplistic. However, considering that the small firm's technology-sourcing methods are rather limited among licensing, joint venture and in-house development, such an approach would be reasonable to some extent.

The second-stage is applied for those who choose technology alliance in the first stage. Although there are various types of technology alliance, this study classifies them largely into two types; equity alliance (such as joint venture and minority equity sharing) and non-equity alliance (such as R&D contract, licensing or research agreement). This study assumes that the decision-makers are considering only these two alternatives because they are the most fundamental and inherently unique in terms of required management style and skills. Pure spot-market exchange based on technology for cash is not included as an alternative because a technology development project cannot be sourced from the market due to its difficulty to evaluate and/or transmit essential knowledge (Vanhaverbeke, et al. 2002).

The two-stage contingency model, despite its deterministic and stylised approach, will provide a helpful mechanism underlying technology-sourcing behaviour of HTSFs. The focus of the literature, therefore, will be on what are the key consideration factors for each decision-making stage that the decision-makers are most likely to adopt. Based on the writer's perception, literature survey and discussion with the industry experts, the next section presents six major theoretical perspectives relevant to the concern of this study in more detail.

4.2 Determinants in stage one

The following six perspectives were not originally designed to resolve how to carry out new technology development projects between in-house development and technology alliance. However, they provide powerful implications to the questions of this study.

■ Transaction cost (TC) perspective

The TC perspective has been widely used to analyse 'make' or 'buy' decisions in the manufacturing industry. However, it can also be applied to technology-sourcing decision-making. Before doing so, let us take a brief look at what TC theory is.

TC theory argues that the ultimate goal of a firm is to maximise profit and that this can be realised by organising transactions in the most efficient way, that is, with the least transaction costs. Fundamentally, there exist two types of governance structure for organising transactions (economic activity): arm's length market exchange (*buy* from outside supplier or merchant) and the centralised controlled hierarchy system (*make* internally or through acquisition). The firm should determine the optimum governance structure by considering and comparing the relative costs of carrying out the transaction under each governance form (Williamson 1991,1985).

TC theory's key assumption is that firms' behaviour is characterised by bounded rationality (their behaviour is intended to be rational but is in fact only limitedly so) and opportunism (they pursue their self-interest with guile). Based on this assumption, Williamson (1985) has argued that the characteristics of a transaction will influence the firm's governance choice between market exchange (buy) or hierarchy (make). For instance, the greater the *uncertainty* of the transaction (in terms of its outcome), the *frequency* of the transaction (determined by the small number of potential partners to deal with the transaction) and the *specificity* of the asset (dedicated and irreversible investment to the transaction), the greater the likelihood that the firm will choose the hierarchy (make) option. This is because, due to bounded rationality and the complexity of transactions, it is impossible to write a once-and-for-all contract stating each party's rights and obligations in every conceivable circumstance.

Each party therefore tries to take advantage of this contractual ambiguity in their own self-interest. Negotiations will be needed to adapt the incomplete contract to unforeseen events, but opportunistic bargaining is likely to occur. In this situation, market exchange will incur high transaction costs, arising from arranging, managing and monitoring transactions across markets (i.e. negotiation, drawing up contracts, managing logistics and monitoring accounts receivable). When transactions get complicated, hierarchy takes over from arm's length market exchange. In contrast, simple transactions that are infrequent and involve standard assets will be organised through market exchange.

In general, TC theory explains well how and why two parties involved in market exchange adopt a relational and bilateral cooperative mode when the frequency of their exchange increases: to prevent hold-up problems and opportunism by their partner. However, it fails to explain why a firm starts carrying out an activity through inter-firm cooperation instead of the other two extremes (arm's length market exchange or hierarchy).[1] To deal with this limitation, TC theorists use the ideas of the market and hierarchy as a reference point around which to organise a framework for the analysis of interfirm cooperation. TC theory states that inter-firm cooperation is an intermediate or hybrid form of governance situated midway on the continuum between market and hierarchy (Garette & Quelin 1994; Williamson 1991). It is an intermediate or hybrid mode because it combines elements of both markets and hierarchy. Distinguishing the attributes of market, hybrid and hierarchy based on five discriminants, Williamson (1991) proposes that the hybrid mode sits midway between the two other governance structures, as seen in table 27.

(Table 25) Attribute of governance structure

	Governance structure		
Attribute	**Market**	**Hybrid**	**Hierarchy**
Contract Law	++	+	0
Autonomous adaptation capacity	++	+	0
Coordination adaptation capacity	0	+	++
Incentive intensity	++	+	0
Administrative control	0	+	++

(Adapted from Williamson 1991, p.281)

[1] In TC theory, inter-firm cooperation mostly denotes equity sharing joint venture.

Unfortunately, the TC theory does not specifically concern non-equity alliance.

Note: ++=strong; +=semi-strong; 0=weak

(1) Contract law: formal, written and anonymous in the case of market, adapted and flexible for the hybrid modes, it is replaced by the power of hierarchy within the firm

(2) Adaptive capacity: a market contract adapts itself more quickly and easily than hierarchy when autonomous adaptation is called for, but the situation is reversed when the disturbance requires coordinated adaptation

(3) Incentive intensity: high in the case of market (self-interest seeking), low within the hierarchy where the link between action and sanction is mitigated by the payment of a salary

(4) Administrative controls: non-existent in a pure market relation, they are necessary to compensate for the weaker incentive intensity of the hierarchy.

Located between two extremes (market and hierarchy) with respect to incentives, adaptability and bureaucratic costs, hybrid is a mixture of both. For instance, the transaction costs of hybrids lie halfway between the two extremes. Compared with market exchange, hybrids give up incentives in favour of superior coordination. Compared with hierarchies, hybrids sacrifice cooperativeness in favour of greater incentive intensity. Similar to the market, hybrids prevent a single firm from gaining complete authority. Similar to hierarchies, hybrids feature incomplete contacts between economic actors at lower transaction costs and more co-ordinated adaptation capacity than the market (Gomes-Casseres 1996). Unlike market exchange and hierarchies, however, the hybrid involves bilateral dependency between the partners. They both commit equity and assets, and agree on how costs and profits are to be divided between them. TC theory highlights the role of asset specificity in governance decisions; hybrid forms will be chosen when the asset specificity of the transaction concerned is of an intermediate degree while extreme asset specificity is handled either by market contract or hierarchy. Williamson (1991), however, argues that hybrids tend to be vulnerable and unstable in the long-term; thus, hybrids will eventually mutate into hierarchical governance (Williamson 1991).

For this study's purposes, the above explanation is limited in several ways. First, the transactions in the above model are largely confined to the intermediate product (mature goods or service) from the buyer-supplier vertical relationship in manufacturing industry. However, special sources of transaction costs need to be addressed when we are considering transactions (i.e., technology project) in high-tech industry. These include technology leakage, technology uncertainty and the need for creative solutions which characterise the transactions in technology development projects, rather than those in mature goods and service supply relationships (Ulset 1996). Second, the above model applies the term 'hybrid' exclusively to joint ventures, ignoring many other hybrids with their own transaction characteristics. Third, according to the above model, a firm may choose 'market exchange' when a new technology project is less asset specific and less uncertain. However, spot market exchange is not a viable option for technology-sourcing decisions. As stated previously, the markets for information, expertise and technology are notoriously inefficient and this information cannot be bought 'off the shelf' because it is difficult to evaluate and/or transmit (Vanhaverbeke et al. 2002; Hennart 1991). Some may say that technology licensing is an example of spot market exchange. However, within the context of new technology development and innovation, it is one of the hybrid modes.

Although the traditional TC perspective's 'make' or 'buy' logic cannot be directly applied to the logic of technology sourcing-decision, it gives a helpful insight. This study has suggested in the earlier section (pp.77) that the first stage of technology sourcing decision-making occurs either within the firm itself or in collaboration with others. In this respect, the TC perspective's 'make' or 'buy' logic can be extended to 'in-house development' and 'technology alliance'. Table 25 above would then be altered into the table below:

(Table 26) Attributes of governance mode for technology-sourcing

	Governance mode for technology-sourcing	
Attribute	**Technology alliance**	**In-house development**
Contract Law	+	O
Autonomous adaptation capacity	+	O
Coordination adaptation capacity	O	+
Incentive intensity	+	O
Administrative control	O	+

Note: +=strong; O =weak

According to the table above, technology alliance is characterised by governance mechanisms distinct from in-house development in terms of (1) stronger incentive intensities, (2) weaker administrative controls, and (3) less coordinated adaptation (Ulset 1996). Here again, the original logic of the TC theory can be applied; the *uncertainty* of the transaction (in terms of the technology uncertainty and its outcome), the *frequency of the transaction* (determined by the number of potential partners to deal with the transaction) and the *specificity* of the asset (dedicated and irreversible investment to the technology innovation) are important factors influencing the technology-sourcing decision. Given this assumption, will the HTSFs replace their decision for technology alliance by in-house development as the degree of these factors are increasing?

Borrowing the idea of the TC perspective, we can assume that the key to making 'in-house development' or 'technology alliance' decisions is to quantify their relative efficiency; simultaneous estimation of the relative transaction costs associated with in-house development and technology alliance is the key to the decision-making and more efficient one should be chosen. The TC perspective suggests that transaction costs associated with in-house development are management costs (shirking costs) while those associated with external sourcing are cheating costs (Madhok 1996); comparing these two is the key to the technology-sourcing decision. However, it is difficult to compare and precisely calculate the management costs and cheating costs beforehand and find the most efficient technology-sourcing mode. Thus, the next paragraphs only briefly consider the source of management and cheating costs which the decision-makers are likely to consider for comparison.

In this study, the transaction is "new technology/product development project". The new technology development project is characterised by a high level of transaction-specific assets at the technology/product category level, uncertain outcome and complexity (Croiser 1998). Firms are unsure exactly which resources are involved and to what extent they are necessary, and how best to ensure the success of the project. Competitive information like this is simply not available for sale on the market. The seller, if there is one, will not reveal such information on the market, in order to prevent information leakage and to keep information asymmetry for a higher price premium (Balakrishnan & Koza 1993). Therefore, implementing a new technology project through external sourcing (together with a partner on a contract basis) is inefficient when too much uncertainty, complexity and a high degree of specific investment are involved. Additionally, drawing up a contract will be difficult when dealing with a complicated project involving another party. In this respect, external sourcing methods (technology alliance) are more costly than in-house development.

On the other hand, the TC perspective argues that in-house development is not without transaction costs. Within the in-house development, transaction costs encompass management costs, associated with internally governing the exchange and coordinating in-house activities (Demsetz 1988; Poppo & Zenger 1998)[2]. In-house development demands a lot of consistent effort from the employees involved. However, hierarchy-like in-house development typifies a loose link between work effort and reward, and this reduces the work intensity and motivation of the employees, leading to extra internal transaction costs (i.e. shirking, agency, monitoring and coordination costs). In-house development through acquisition is common in technology innovation projects. However, this may also cause higher internal management costs due to a distorted incentive structure. For instance, large firms acquiring small entrepreneurial firms may find it very difficult to replicate the incentive structure of the small firm (Pisano 1989; Williamson 1985). In addition, it will be more difficult to administer, control and motivate the acquired firms within the acquiring firm's management system. In these cases, in-house development may also incur severe internal transaction costs.

In summary, important trade-off considerations have to be addressed when choosing between in-house development and technology alliance for new technology projects. To work out what the trade-offs in fact are, firms must consider the expected transaction costs of both in-house development and technology alliance simultaneously. The transaction costs in the former tend to relate to the firm's capability to handle the in-house management of the technology project in a cost-effective way (i.e. reducing shirking costs) while the transaction costs in the latter tend to relate to the characteristics of the transaction (project) such as frequency, asset specificity and uncertainty. Technology alliance would be a better option when the estimated internal transaction costs (management costs) are larger than the estimated external transaction costs (cheating costs) of the project, while in-house development

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[2] The transaction costs of in-house development may include both management costs and internal production costs. However, the TC perspective normally ignores the production costs aspect by holding it constant and emphasising the management costs aspect. This faces severe criticism by the resource-based (RB) theorists (i.e., Madhok 1996).

would be better when the former is smaller than the latter. The two modes of governance choice, then, essentially involve a trade-off between two sets of costs. Further examination is necessary when both are equal. The following table simplifies this assumption.

(Table 27) Costs-based technology-sourcing decisions

		Internal management costs (shirking costs)	
		High	Low
External transaction costs (cheating costs)	High	?	In-house development
	Low	External sourcing	?

However, the actual value of a technology project in terms of its internal vs. external costs usually does not clearly enter into the decision-making process (Kurokawa 1997). Also, it is difficult to identify each type of transaction cost precisely and then calculate the relative advantage of each technology-sourcing option, unless the chosen governance form is actually observed (but this means the one not chosen cannot be observed). Amid such difficulty, empirical studies do not always reflect the theoretical prediction. For instance, Folta's (1998) study of 402 US biotechnology firms finds that they choose strategic alliance over internal development when the required technology for the project involves a high degree of external transaction costs caused by a high degree of asset specificity and a high degree of uncertainty. As there is no clear-cut checklist and cost-benefit breakeven analysis and divergent empirical findings, it is necessary to identify various key factors, related to internal and external transaction costs, and how these will influence the trade-off between the two modes.

■ Resource-based (RB) perspective

Drawing on Penrose's (1959) study, RB perspective views a firm as a collection of sticky and imperfectly imitable resources and capabilities. Broadly speaking, a firm's non-imitable resources consist of all of its unique, tacit, complex and firm-specific assets. Examples are knowledge, employees, information systems, organisational structure and routine, rules, procedures and capabilities. These resources are harder to transfer across firms because of their incomplete factor market, isolating mechanism, path dependence, social complexity and causal ambiguity (Barney 2001; Teece, et al. 1997). No two organisations are exactly the same because their resources and capabilities may differ (resource heterogeneity) and these differences may be long lasting (Medcof 2000). A firm's long-term survival depends on its ability to maintain unique and costly-to-copy resources and capabilities (Lei 1996; Conner 1991). To RB theorists, the unique and difficult-to-copy resources are the source of the competitive advantage and superior performance of a firm (Wernerfelt 1984).

RB theorists posit that superior profit is based on the firm's valuable resources and capabilities. Thus, they argue that the ultimate goal of a firm should be to earn long-term superior profit through exploiting and developing its resources (Ricardian rent). They believe that in order to maximise long-term superior profits, the firm's competitive strategy should focus on how to use its existing resources and how to develop additional unique resources that it may lack (Rouse & Urs 1999; Barney 1991). In this respect, access to external resources through strategic alliance is becoming more and more essential, especially in the high-tech industry, because no-one is perfectly equipped with everything. To RB theorists, strategic alliance is a value-creating process of inter-organisational relationship in which valuable resources flow and are exchanged between organisations (Rothaermel 2001).

According to the RB perspective, strategic alliance emerges because of hierarchy failure; idiosyncratic firm resources and capabilities required for competitive advantage (called strategic resources) are not always available within the individual firm. They cannot always be developed internally at an acceptable level of quality and efficiency because of the Penrose effect (diseconomies of size arising from excessively diminishing returns to scale of production) or inadequate capability within the organisation (Mahoney & Pandian 1992). RB perspective argues that strategic alliance is more efficient than any other governance mode, such as spot market exchange and hierarchy, when a firm tries to carry out value-creating activity[3]. In explaining the rationale of this argument applicable to technology-sourcing decision, the RB perspective stresses two factors as having a key role: the characteristics of necessary resources and the firm's capability.

[3] It means any activities that are related to improving the capability of a firm by creating valuable and firm-specific resources. It denotes new technology development projects in this study.

First, the characteristic of the resources that a firm seeks is a significant determinant of technology-sourcing decisions. The new technology project is itself the strategic resource that a firm tries to develop as a competitive strategy. According to the Madhok (1996a), such strategic resources are a combination of *generic resource* (where the value is independent of the firm within which it is housed) and *embedded resource* (where the value is specialised to the employer largely due to firm-specific idiosyncratic routines resource/capability). In particular, the *embedded resource* is dependent on a firm's path dependency (long and difficult learning process), historical context (being in the right place at the right time), embedded routine and social complexity (mixture with the firm's culture, reputation and customers) – all of which form the foundation for sustainable value (Conner 1991). The generic and embedded resources are fused together; one will lose its value without the other. The new technology development project aims to develop the competitive technology/product with relatively more embedded resources than generic ones.

No firms are perfect (bounded rationality in terms of organisational capability) so they have to complement and supplement their existing technological resources with other firms, which may supply the needed resource and thus create further value-generating resources. If the purchase of such (strategic) resources from other firms can be efficiently conducted through market exchange, this is preferable. However, strategic resources will not be perfectly tradable and sellable by the seller (market failure) as they tend to consist of implicit, tacit and context-specific know-how: the causal ambiguity of the providing firm's strategic resources prevents the buyer from understanding what exactly the strategic resource is and how it makes the providing firm so successful (Chi 1994). Due to the nature of the valuable resource (firm-specific, tacit, inimitable and un-tradable), the buyer cannot fully capture the value that the seller originally sells through the market exchange.

In addition, the strategic resources of the providing firm tend to commingle with unwanted or less valuable assets, but the latter cannot be disposed of without the loss of the former (Hennart & Reddy 1997). In this respect, acquisition is a poor choice from the buyer firm's perspective unless it buys the whole bundle; but buying the whole for its part is inefficient. However, close interaction between firms remains a viable option since it helps firms smoothly transmit tacit, uncodifiable, indefinable and inseparable knowledge, which is impossible in spot market exchange. During the process, the recipient firms can also deal with the causal ambiguity of the strategic resource by observing or learning-by-doing (Das & Teng 2000).

In short, developing a new technology project means building strategic resources that promise to enhance the firm's ability to create value. Pure in-house development is not cost efficient since firms are capable only in certain domains, while pure market exchange or acquisition is also inefficient due to the imperfectly mobile, inimitable and inseparable nature of desired resources. Alternatively, strategic alliance will thus be the best means as it enables deployment and acquisition of firm-specific, tacit and inimitable strategic resources better than spot-market exchange, and the capture of untradable ones more efficiently than any other governance modes such as acquisition.

Second, holding the characteristics of resources needed to develop constantly, a firm's consideration for its capability (what the firm can do and cannot do) influences which governance decision is adopted. Organisational capability means a firm's capacity for undertaking particular productive activity by using the firm's resources. To understand the logic of capability considerations, it is necessary to exemplify how it is applied to the case of 'make' or 'buy' decision. A firm's boundary decision is an effort to discover the best way to gain access to valuable resources and capability, and, not least, minimise the transaction costs (Barney 1999). TC perspective stresses that markets fail as a result of high transaction costs caused by opportunism and bounded rationality. RB perspective refutes such opportunism-oriented ideas by arguing that the market may be preferred, in spite of market failure caused by high transaction costs and opportunism, and claims that, conversely, hierarchy may be preferred if it is the best way to create and gain valuable resources, even if market transaction costs are zero and hierarchy management costs are positive (Madhok 1996). This reflects the fact that capability consideration is the predominant logic over the opportunism consideration in 'make' or 'buy' decision, according to the RB perspective.

Why are capability considerations the predominant logic rather than the transaction costs and opportunism considerations in making boundary decisions? RB perspective criticises TC perspective for failing to take into account the intrinsic limitations on a firm's capability, and ignoring the scale and capability difference among firms (in terms of production capability).

Madhok (1996) states:

> The more relevant consideration in boundary decision is comparing the sum of the total managing costs and internal production costs (total cost of hierarchy) on one hand and of the total of the transaction costs and external production costs (total costs of using the market) on the other. By implicitly equating external and internal production costs, TC analysis makes the comparison both simplistic, being between (shirking) costs and transacting (cheating) costs only, and unrealistic.

Consider a situation where the transaction costs of economic activity through the market exchange are constant and there are no shirking costs of doing it through the hierarchy. In this case, hierarchy should be the preferred mode, according to the TC perspective. But if the firm lacks the relevant capability for such economic activity internally, choosing the hierarchy is not a realistic boundary decision for the firm under any circumstances; it still should resort to a non-hierarchical form despite the threat of the opportunism and high transaction cost in the non-hierarchical form [4]. In this case, hierarchy fails, not because of high internal management costs (i.e. shirking costs) but because of the high costs of producing internally.

In summary, the cost of using hierarchical governance to acquire capabilities must be compared with the cost of using non-hierarchical governance to gain access to capability. In doing this, understanding the firm's own capability is a key determinant of the firm's boundary decision. If the firm cannot access special capability internally, non-hierarchical governance is the best option; opportunism is simply part of the cost of gaining access to the special capabilities controlled by another firm that cannot be developed internally[5]. Therefore, considering only transaction costs is not sufficient to decide governance choice; without considering transaction

[4] The non-hierarchical form includes both pure market exchange and strategic alliance. However, the RB perspective hardly consider pure market exchange as competitive govern option or boundary decision. It normally views market exchange as contract based mutual reliance such as strategic alliance (see Barney 1999).

[5] Of course, the firm tries to minimise the threat of opportunism under this circumstance and this will be reduced by choosing intermediate governance mode such as strategic

alliance.

costs and opportunism, capability consideration is sufficient in analysing governance decision of a firm.

How, then, does capability consideration influence the technology-sourcing decision? According to the logic mentioned above, a firm should pursue hierarchy-form if it is able to access new technological resources internally while it should pursue non-hierarchy, (i.e., technology alliance) if it is not able to do so. The RB perspective argues that, unlike boundary decision for typical economic activities such as accessing distribution network and marketing and supplying channels, technology-sourcing decision for innovation activity demands a special attention to capability consideration, but still opportunism is not the critical factor in technology-sourcing decision. Having this assumption, the RB perspective argues that, all things being equal, the more the firm's capability is characterised by imperfect mobility, imperfect imitativeness and imperfect substitutability, the more likely it is that the firm will get involved in technology alliance; conversely, the firm with relatively weak capability is less likely to engage in technology alliance (Das & Teng 2000; Mutinell & Piscitello 1998).

In rapidly evolving high-technology industries, it is quite rare that a firm is sufficiently innovative on its own; Microsoft and Intel (the leading global high-tech firms) and Mirae and Trubotek (the leading and successful high-tech firms in Korea), are actually getting the most valuable knowledge resources and information from their alliance partners (Business Korea 1997). Firms with a diverse technology portfolio and technological capability are better able to recognise the opportunity/value of new technology and find sources of external knowledge. Resource-rich and capable firms have adequate learning and organisational capability, the most essential prerequisites for technological innovation, and thus have better prospects of developing through alliance the resources necessary to further strengthen their capability. In addition, they are also able to attract other firms as potential partners because they have more to offer, bolstering their bargaining position. Therefore, technologically stronger firms are more likely to form strategic alliance than technologically weaker firms.

As far as technology innovation is concerned, the RB perspective is strongly in favour of various external sourcing and inter-firm cooperation, arguing that innovation requires strategic resources from various origins. However, technology alliance can be chosen only when both potential partners feel that they have something to share to complement each other's limited resources, leading to possession of strategic resources. The basic condition for alliance is, thus, that a firm must have resources to get resources (Eisenhardt & Schoonhoven 1996). In this respect, resource-poor firms (those with relatively weak technological capability), although they have a greater need to acquire necessary resources through external sourcing, are not attractive as alliance partners as they have less to exchange (Burgers, et al 1993).

In summary, a firm's capability impacts technology-sourcing decisions. No firm is replete with sufficient internal resources for technological innovation. Going for external sourcing is the immediate concern. Given this assumption, it is obvious that high-tech firms of both strong and weak capability continue to seek to complement and supplement their existing capabilities through technology projects. However, the crux of the question is who can better exploit external sourcing. In this respect, the RB perspective argues that strongly capable firms are more likely to end up with realising external sourcing (strategic alliance) since they have more to share and greater capacity to absorb and learn from external sources. Therefore, firms must critically analyse what types of resource they need and what kind of capability they possess and are trying to build before they make technology sourcing-decisions.

■ Resource dependence (RD) perspective

In their book 'The external control of organisations: a resource dependence perspective', Pfeiffer and Salancik (1978) view the organisation as a coalition of resources with the chief objective of survival in a competitive environment. They argue that the behaviour of the organisation is best understood by analysing the environmental context of that behaviour. Unlike typical organisation theories in which the environment has a deterministic influence to which organisations adapt their strategies, structures and processes, the RD perspective posits that organisations are passive-reactive agents of change that attempt to manage their external environments. That is, organisations can implement a variety of strategies designed to modify existing environmental conditions.

Environmental conditions mostly involve varying degrees of dependence on external entities within the environment in which firms participate for the resources they require to operate (Kotter 1979). Similar to RB perspective, the RD perspective contends that most organisations do not control all the resources necessary for survival because they are not internally self-sufficient; they have to depend on other organisations to provide them. Organisations that provide needed resources frequently seek accommodations in return. As dependence on key resource providers increases, so does the likelihood that an organisations will accommodate to their demands (Zinn & Rosko 1997). Therefore, a firm tries to change its organisational structure and behaviour to reduce the dependence on other firms and, at the same time, maintain a steady flow of resources from the environment (Gray & Wood 1991; Oliver 1990). Strategies suggested to achieve this goal include the prudent selection of operating domains (i.e., industries with limited competition and regulation coupled with ample suppliers and customers), mergers, cooptation, coalition, contractual relationships, public relations efforts to influence regulation, activities designed to reduce competition and structural changes (Carroll 1993; Zeithaml & Zeithaml 1984). These strategies help firms proactively manage the vagaries of an uncertain external environment in which resource exchange and competition are always problematic, and enable them to access resources and stabilise transactions and outcomes.

Among the many organisational structures mentioned above, strategic alliance plays a prominent role in managing organisational interdependence. Interdependence is a situation in which another has the discretion to take action that affects the focal organisation's interests. When this interdependence between two independent actors becomes problematic because of the unpredictability of the relationship and the difficulty of ensuring mutual advantage, the greatest solution involves social mechanisms. Social mechanisms include linkages to the environment, social co-ordination of interdependent actors and association with independent others through channels of communication, persuasion and negotiation (Pffefer & Salancik 1978). RD perspective calls this normative coordination of interdependence: rather than making an explicit contract to reduce unpredictability between interdependent organisations, norms of reciprocity and normative restrictions govern conflict and overly competitive behaviour, and thus reduce uncertainty and violation of the norms (commonly and widely shared set of behavioural expectations).

Relying on social mechanisms and normative restrictions may help reduce the incidence of sudden change or surprise and stabilise the future course of exchange, thus generating common expectations for independent firms operating within a certain set of circumstances. However, from the managerial and practitioner's point of view, such social mechanisms are not always a useful method for dealing with organisational interdependence and coordination. This is because norms represent a social consensus, and it is not possible to mandate a normative environment to suit all of an organisation's needs (Pfeiffer and Salancik 1978). More direct methods of achieving interorganisational coordination should be established, namely interorganisational cooperation, mostly in the form joint ventures.

The RD perspective argues that, rather than simply sharing necessary resources, strategic alliance helps reduce uncertainty and promote stability in an environment in which firms are in a position either of competitive or symbiotic interdependence with others (Pate 1969). The best conditions for alliance formation occur when the uncertainty resulting from competitive and symbiotic interdependence would be most problematic (Pfeiffer & Nowak 1976). Competitive interdependence may exist between similar sized firms in the same industry while symbiotic interdependence can exist between organisations in different industries (i.e., interdependence between supplying and customer organisations in the value chain). Here, interdependence either competitive or symbiotic is most problematic when the level of industry concentration is intermediate.

For instance, at very low levels of industry concentration in which many firms are active in the market, interorganisational linkage such as joint ventures will be less effective. That is because many organisations must be linked and the level of interdependence between certain actors is minimal. At very high levels of industry concentration, in which relatively small number of firms are active in the market, tacit interfirm co-ordination will be sufficient, since there are only a few other firms to monitor and each firm can observe the others' behaviour and accommodate readily. Therefore, when the level of industry concentration is intermediate in which interdependence uncertainty is greatest, strategic alliance is mostly likely to occur (Oliver 1990).

The RD perspective also concerns how market change influences the proclivity of alliance formation (Burgers, et al. 1993). It argues that market change in terms of market decline plays the driving role for alliance formation.

For instance, firms are relying on task environment for inputs essential for their activities. The needs to have necessary resources create dependencies between firms whose nature and extent depends on how scarce their resources are (Park, et al. 2002). As market declines, critical external resource becomes scarce. Scarce resource market creates greater dependence between firms. Resource scarcity motivates many firms to hedge against the uncertain resource flow and access based on mutual control. Strategic alliance becomes mechanism to solve this problem and helps to acquire external resources faster and efficient than acquire them independently. We frequently observe that many firms ally with their major client, technology provider and competitors to capture steady customer demand, exit declining markets and seek new opportunity (Kogut 1988). In growing market, on the other hand, the proclivity to alliance will decline. The benevolence of growing market reduces organisational dependence on key resources and competitive uncertainty (Pfeffer & Salancik 1978). Firms feel less threat for securing steady resources and concern more securing independence on other firms.

In sum, the RD perspective emphasises how market change leads a firm to alliance choice. It particularly emphasises the role of industry concentration level and market growth; the firm will mostly likely to choose alliance when the level of concentration is intermediate and the market is decline. Although the prediction of the RD perspective has been mostly applied to examine the service industry such as hospital industry (See, Song 1995), it has an important implication to the technology-sourcing decision in high-tech industry. For instance, the number of players in the incumbent market would influence the technology-sourcing decision; too many or too little competitors in the market would likely to diminish the need for technological cooperation due to strategic and legal reasons. At the same time, market condition would be also influential factor. In high-growing market such as telecommunications industry, the HTSFs may easily get relevant informational resources from various routes via, for instance, government technology assistance or training programme. Thus, the firm may not need to form external sourcing if there is no difficulty of intaking valuable resources. Further study, therefore, will be necessary to test how these suggested conditions for strategic alliance would also influence HTSFs' technology-sourcing decision into internal or external sourcing.

■ Market power (MP) perspective

Similar to resource dependence (RD) perspective, the MP perspective mostly concerns the environmental condition of a firm. The MP perspective was dominated in the 1980s by Michael Porter's competitive strategy (1985). It suggests that the competitive intensity of industries is determined by five factors: the degree of rivalry dividing up the market, the power of suppliers and buyers, new entrants and potential substitutes for the product or service. MP pespective posits that firms should transact through the mode which best maximises profits by improving their competitive position vis-à-vis five factors (Kogut 1988). The free flow of capital and the internationalisation of many global firms expand the global market at faster rates (see, Hymer 1972). Faster market growth attracts many new entrants, who may discover new technology, new products or a new supply of labour, leading to furious competition. Severe competition drives firms to continuously reinvest their profits and extend their market to continuously develop new products and ensure self-preservation (Hymer 1972). In high-tech industries, the uncertainty created by rapid change and a faster rate of innovation on a world scale results in more firms devoted to research and development. New technology rapidly becomes obsolete as new needs and wants arise. This is the engine of a continuous cycle of innovation and trickling down, appropriately called 'creative destruction' by Schumpeter. Firms slow in technological innovation will not survive the market.

Scholars have found that the number of strategic alliances is increasing in this hyper-competitive environment, such as telecommunications systems and services industries, in which firms previously did not pursue such alliances (Harrigan 1988). As many firms' existing markets are squeezed and made competitive by new entrants, they have to defend themselves and seek new markets to conquer. Forming a strategic alliance can help firms adjust their strategic posture, or defend their current strategic position, in the face of forces too strong for a firm to withstand alone. Also, forming an alliance with a potential competitor may reduce severe competition; a firm can achieve a stronger position working with its partner than it would in isolation (Faulkner & de Rond 2000; Burger, et al. 1993). In a severely competitive environment, a firm never knows in advance whether its actions will invite retaliation, or whether its rivals will initiate competitive moves directly impacting its market share. Firms thus form alliances to protect their existing market and, at the same time, to expand or develop new markets.

In summary, the MP perspective indicates the primary antecedent of alliance formation is purely strategic: to defend the firm's strategic position in the existing market and to exploit the market opportunity. In particular, the MP perspective stresses the opportunity side of market growth as antecedents of alliance formation. Market growth and opportunity are highly related. In growing market, the firm expects to have plenty of opportunity to develop new technology/product and exploit existing resources and capabilities. Growing demand also creates numerous niche markets that can be filled with new product/technology by firms. In the growing market, firms need to achieve more market predictability power to preempt the first mover advantage as well. So, firms enter into alliance to capture the windows of market opportunities in growing market. In declining market, sales and profits declines. Firms spend less on acquiring new resources. As the opportunities in declining market are fewer, the benefits of alliance are also offset by the costs of its setting-up and management. Most of all, unclear prospect of the declining market further discourages alliance formation as financial return is uncertain. Therefore, faster market growth is more likely lead the firm to choose strategic alliance.

Telecommunications industry is certainly one of the fast growing industries among others. Small firms in the industry may find a lot of opportunities to increase their benefits. However, small firms normally have relatively small market share and may have disadvantage in exploiting market opportunities compared to large market sharing firms. Thus, they may not properly capitalise on their newly developed technology. In addition, due to the growth of venture capital, there are a lot of similar-sized look-alike small organisations who produce similar level of technological advancement. In consequence, they may pursue new technology project through external sourcing, so that they are better able to preempt and commercialise technological opportunity in the growing market, as well as protect themselves from competitors. Further study will be necessary, therefore, whether the market grow are positively influence the firm's firm's technology sourcing decision into external sourcing.

■ Social network (SN) perspective

SN perspective is based primarily on sociology and organisational theory. Social networks can be defined as a set of nodes (i.e., persons, organisations) linked by a set of social relationships (i.e., friendship, transfer of funds, overlapping members) of specified type (Gulati 1998). Unlike classical and neo-classical economic theories assuming that economic actions are influenced by rational and self-interested behaviour, SN theory posits that economic activity cannot be analysed without considering the social context (structure) in which it occurs. All individuals and institutions are socially construed; thus, their action and activities do not take place individually in a barren social context, but are affected by social structure, social relations and social ties (Granovetter 1985). The key concept here is embeddedness, which is central to SN perspective. Embeddedness goes beyond the immediate ties of firms, and includes consideration of how many participants interact indirectly with each other, how likely future interactions are among participants and how likely participants are to talk about these interactions (Jone, et al. 1997; Granovetter 1985). Strategic management scholars relying on the SN perspective argue that the structural, cognitive and cultural contexts are important sources of competitive advantage for firms, influencing the firm's strategic behaviour and its performance. While the SN perspective spotlights how the embeddedness of individual firms influences their strategic behaviour, this logic can be extended to explaining alliance phenomena, that is, how embeddedness of individual firms within the social network plays as an antecedents of their decision for alliance (i.e., Stuart 1998; Gulati 1995).

If a firm is already embedded in an existing network, sharing and exchanging information, why does it bother to form an alliance with certain partners at extra cost? The SN perspective argues that, although firms might share much information within the network, the network does not always provide the information vital to each firm, the unique information that varies across the firm's operational inefficiencies, resource scarcity and business units (Borys & Jemison 1989). Relying on social networks to furnish such information might be less useful, while unitary (conventional) organisations are also less able to solve these problems since they are inflexible and inefficient (Grandori & Soda 1995). In uncertain and volatile industries such as high-tech industries, sharing firm-specific information is essential for new product development (Jones, et al 1997). Therefore, firms enter into strategic alliance to obtain better content and quality of information necessary for the specific requirements of the firm.

The SN perspective uses the same definition of strategic alliance as found in the economic literature: long-term purposeful arrangements among distinct but related for-profit organisations to gain competitive advantage vis-à-vis competitors outside their network (Jarillo 1988). Unlike many economic perspectives, however, it discusses the strategic alliance not at the firm or dyadic (alliance) level *per se* but at the network level in which the strategic alliance is embedded. Although strategic alliance consists essentially of dyadic exchanges, the SN perspective assumes that any key precondition and process associated with a single alliance relationship cannot be shaped and analysed without considering the firm's previous and existing relationships with other members within the network (Gulati 1998). SN perspective states firmly that, although firm- and industry-level transaction factors are significant antecedents of alliance formation, strategic alliance can only be driven in large part by recognising alliance opportunities provided by the firm's existing network relationship with other firms. This simply reflects the tenet of the theory that interaction and ultimately cooperation would likely happen among firms who know one another. Viewed from this standpoint, the perspective elaborates the impact of a firm's embeddedness level in the social network on the sequence of events in alliance formation; how the firm independently initiates the need for an alliance, identifies the best partner available and chooses an appropriate contract to formalises the alliance (Ring & Van de Ven 1994).

Indeed, the level of embeddedness of a firm in a social network acts as a structural antecedent, facilitating the establishment and governance of the strategic alliance (Mizruchi & Galaskiewichz 1993). Although there is no official agreement, scholars widely acknowledge that the centrality level of a firm denotes the firm's embeddedness level in the social network (Eisenhardt & Schoonhoven 1996; Powell, et al. 1996). In high-tech industries, the centrality of a firm in the network simply means the status of the firm, perceived as the quality or importance of the firm's previous contributions to the advancement of technological knowledge (Podolny & Stuart 1995). The more that a firm's previous innovations are perceived to serve as the foundation for successful innovation paths, the higher the firm's status. Stuart (1998) argues that a high-tech firm with higher status enjoys a prestigious position in the network. For instance, a high-status firm takes crowded position as followers gather and concentrate in the firm's area of technological speciality. A high-status firm also earns technological prestige as it develops path-braking technology and becomes the foundation for imitation and elaboration by others. As other external resource holders may seek access to the firm to pursue functional integration, organisational learning and benchmarking, the high-status firm inspires a web of relationships with them and is at the centre of the technological activity in the market.

The SN perspective argues that firms centrally located in the network are more likely to form alliances more often than otherwise comparable ones, since they have better opportunities to do so. For instance, the high status and reputation of a firm signal the firm's product quality and market acceptance, attracting other firms who want to associate with them. In contrast, firms lacking technological status and reputation may be unaware of the opportunities to learn, have little information on other firms' activities, and are thus forced to continue on their own (Eisenhardt & Schoonhoven 1996). Centrally located firms take information–rich positions. They often have more timely access to promising new venture opportunities and to the latest information on new technology via their diverse portfolio of ties (Powell, Koput & Smth-Doerr 1996). At the same time, centrally located firms are better positioned to access, conveniently and inexpensively, reliable information about the quality and trustworthiness of the other actors in the network, either through currently related parties, shared third parties or previous direct ties (Uzzi 1997; Gulati 1995). This enormously reduces the costs of searching for and screening potential partners, and eases the process of learning which collaboration to pursue and how to function within a context of multiple relationships. As such firms proceed with a strategic alliance, they develop experience at cooperation. In turn, firms more experienced in alliance tend to pursue more strategic alliances as they accumulate experience from the previous alliance and build reputation (Kogut & Zander 1992).

Despite wide adoption within various industry settings, the SN approach has paid relatively little empirical attention to technology-sourcing decision among HTSFs. As SN perspective criticises, too much emphasis on opportunism and economic-based approach may not mirror the true nature of technology-sourcing decision process of HTSFs. For instance, frequent and repeated transactions within the social network effectively reduce (rather than increase) opportunistic behaviour through proactive information exchange and mutual adaptation for better coordination (Liebeskind, et al. 1996). Thus, social property such as trust or previous experience may play as a dominant control mechanism in explaining the technology-sourcing decision.

■ Institutional perspective

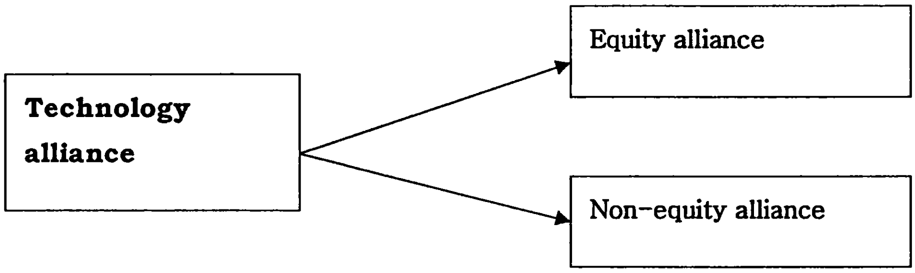
The institutional perspective posits that strategic alliance is institutionalised (taken-for-granted) in its industrial setting. It contends that the institutional environment is composed of rule-like expectations governing appropriate organisational forms, practices and behaviour (Oliver 1997; Scotts 1987). These institutional elements, once established as legitimate means to achieve organisational goals, have a powerful impact on an organisation. Survival is dependent on organisational conformity to institutional pressures (Myer & Rowan 1997). Institutional isomorphism helps organisations survive by offering them legitimacy, buffering them from turbulence and promoting stability. Organisations engage in institutionally established strategic alliance not because it represents a better set of actions, but because they are compelled to do so by coercive, mimetic or normative institutional pressures relating to strategic alliance within the social network. The decision makers within a firm no longer even question the appropriateness or rationality of these activities. Once alliance emerges as a practice, it is copied over time by others and becomes generally accepted.

Technology alliance is in vogue in South Korea during the last five years. Further study may be necessary to see if there is institutional isomorphism or legitimacy pressure for technology alliance in carrying out technology project.

4.3 Determinants in stage two

For firms choosing an in-house development for new technology development, no further decision-making process is needed except that they proceed with it. However, firms opting for the external-sourcing method must proceed to the second phase of the decision-making process: how to structure it, as seen in the figure below.

(Figure 4) 2nd phase of technology-sourcing decision; structuring alliance



As they did in the first phase of decision-making (in-house development vs. external sourcing), the decision-makers should consider several economic, environmental, strategic and organisational behavioural aspects to establish an appropriate structure of external sourcing, largely between equity and non-equity technology alliance. However, rationale, preference and logic of the decision-making in the second stage are different from the first stage, thus different decision criteria should be regarded.

Many technology alliances fail because the parties involved are strategically or organisationally incompatible, are unable to trust each other and do not have the appropriate means to elevate and resolve the conflicts (Kale & Puranam 2004). Thus, the decision-makers of HTSFs have to be more concerned with the issues of how to implement and manage technology alliance successfully. However, more important prior issue will be design-related, including deciding on the optimum governance mode and the level of the equity ownership of the inter-firm relationship. In fact, the failure of the alliance is highly linked to the problems with the fundamental design of the structure of the alliance.

In this respect, the decision-makers have to consider which potential governance choice would be efficient at dealing with the partner in terms of the decision-making autonomy, knowledge exchange and profit-cost sharing (coordination and control of the relationship) given the technology project at hand. In addition, the degree of writing complete contracts and potential cheating and appropriation hazards should be also mirrored in structuring technology alliance (Sampson 1999). Drawing on the TC, RB and confidence-based perspective, the next section will discuss what the conditions should be considered for deciding equity and non-equity alliance.

■ Transaction cost (TC) perspective

The TC perspective is not only concerned with the antecedents of the alliance formation but also with the optimal condition for coosing appropriate alliance mode. In fact, the TC perspective is more powerful in explaining the superiority of equity alliance than non-equity alliance. The TC perspective enhances the logic that although alliance is chosen instead of in-house development or internalisation, there is still the danger of transactional hazards within alliance such as partners' opportunistic behaviour in the pursuit of private incentives and bureaucratic costs in the process of co-ordinating inter-firm exchange (Park 1996). Thus, the ultimate purpose of structuring alliance governance is for the stability of alliance: to control opportunism and guarantee fair sharing of reward from the cooperation (Garcia-Canal 1996). Choosing either equity or non-equity alliance is, therefore, determined by considering ownership, control and profit distribution issues. Equity alliance is more akin to hierarchy-like collaboration imposing high level of an ownership and controlling power (Pisano 1990). Equity alliance is recommended when a transaction between partners accompanies a high level of transaction specific complexity and uncertainty, while non-equity alliance, a less legal and market-like structure, is recommended when cooperative tasks are complementary rather than competitive.

The magnitude of the transaction .costs, the core concept of TC perspective, is still valid in explaining the governance choice of the technology alliance. Simply put, the TC perspective argues that the decision-maker should notice the cost side of the technology alliance, mostly the transaction costs that may occur during the alliance relationship, when deciding relevant alliance mode. A lot of many subtle problems will always arise in the technology alliance. For instance, both partners may fail to foresee the dangers of opportunistic behaviour; partner's non-commitment to the success of the project; and the difficulty of modifying the terms and conditions of the contract in the uncertain future, may all be factors which together raise the transaction costs in terms of monitoring, enforcing, and regulating each partner. Therefore, the role of structuring technology alliance is to establish how to efficiently minimise and reduce such transaction costs. In this sense, the TC perspective upholds that the level of the transaction costs influences the governance decision between equity vs. non-equity alliance.

Potential transaction costs caused by opportunistic behaviour of the potential partner is not uncommon in technology alliance. For instance, in the course of undertaking technology collaboration, the small firms have to make investment in equipment, human resources training and materials, much of which may be specific to the particular technology project and have limited value in other uses. This creates a possibility that the partnering firms will behave opportunistically and delays or decreases the payments. Conversely, the small firm may behave in inopportunely with the partner if the latter has made significant investments in preparation of the technology project. These are hold-up problems in which one or both partners invest in specialised assets that have limited value outside the relationship (Kale & Puranam 2004). In these cases, renegotiation is unavoidable and, correspondingly, the opportunistic renegotiation is highly probable. Significant litigation and settlement costs will be incurred. To avoid this, the firm has no other option but to comply the partner in order to avoid a lengthy legal solution. To prevent such potential problems caused by hold-ups, the firm should organise the alliance in such a way as to minimise them-that is, equity-based cooperation.

Apart from the transaction costs explanation, the choice of technology alliance structure is also explained by aspects of coordination and appropriation costs as well. For instance, the appropriation problem, which originated from pervasive behavioural uncertainty and contracting problems (Pisano, et al 1988) can be resolved by joint equity ownership (that defines the owner of hierarchical control) by the respective partners. The greater the appropriation concerns, the more hierarchical control is desirable in organising the alliance, and the more likely that the equity alliance will be chosen (Gulati & Singh 1998). Meanwhile, coordination costs arise from the organisational complexity of dividing tasks among partners (Gulati & Singh 1998). The cost of coordination increases if it is difficult to anticipate and evaluate the activities of the alliance partner, and an equity alliance may overcome that difficulty by providing mechanisms for internal monitoring and supervision.

In summary, when decision-makers of HTSFs structure a technology alliance, they have to clearly evaluate the hold up-hazard that they may encounter in the relationship and the amount of effort necessary to avert such hazard. Therefore, it is essential for them to clearly evaluate the extent of possible opportunistic behaviour, appropriation conflict, contract completeness and relationship-specific assets. When the levels of these are high, alliance with a higher level of equity ownership such as a joint venture will be necessary. In equity alliance, both partners gain a seat in the board and decision-making voting rights as a condition of the equity stake. In consequence, equity alliance will provide both partners with a means to exercise greater control, align incentive and interest of the two partners and oversee the partners to prevent adverse partner behaviour.

■ Resource based (RB) perspective

Compared to the TC perspective of stressing the cost efficiency of the technology alliance as determinants of structuring technology alliance, the RB perspective concentrate more on the value-creating potential of the technology alliance. Stated earlier, the RB perspective posits that strategic alliance is formed to inflow valuable resources and capability that cannot be developed internally. As the objective of the technology alliance is successful leverage of the technology being accessed, what types of resource are exchanged and how to exchange and coordinate them between the partnering firms are the most critical issues in structuring technology alliance (Chen & Chen 2003; Das & Teng 2000). At the same time, how to effectively complement contributed knowledge from the partner is also a significant consideration criterion in structuring technology alliance (Craven, et al.1993). When the chosen mode of technology alliance fits all these conditions, then maximum value creation potential for the HTSFs will materialise through technology alliance.

The RB perspective argues that the types of resources that potential partnering firms may contribute constitute a key dimension affecting the way resources are to be shared in alliances. Das & Teng (2000) discuss how resource profile to be exchanged by the partners would determine the structural preferences of strategic alliance. Miller and Shamsie (1996) further classify resources profiles as property-based resource and knowledge-based resource. Property-based resources are legal properties owned by firms with clear property rights including financial, physical and human resources, patent, copyright, etc while knowledge-based resource refers to a firm's intangible expertise and skills that are not easily transferable due to their ambiguity.

The following table summarises how resource profile between partner firms determines the governance choice of alliance.

(Table 28) Resource types and a firm's structural preference for alliance

	Partner firm (B)	
Firm (A)	**Property-based resource**	**Knowledge-based resource**
Property-based resource	Non-equity alliance (unilateral contract-based alliance)	Equity alliance (equity joint ventures)
Knowledge-based resource	Equity alliance (minority equity alliance)	Non-equity alliance (bilateral contract-based alliance)

(Adapted from Das & Teng 2000)

For instance, when two partners are expected to exchange knowledge-based resources which tends to be less protected by property law due to its tacitness, vagueness and ambiguity (Miller & Shamsie 1996), firms prefer to choose non-equity alliance. Unlike equity alliance in which firms have to fully exposed to and deeply involved with the other, non-equity alliances prevent partners secretly capturing valuable knowledge and becoming competitor. Example would be joint R&D. When two partners are expected to exchange property-based resources, a less engaged alliance form should serve well since neither firm will be interested in secretly acquiring the other firm's property based-resources. When a firm is contributing property-based resources in exchange for knowledge-based resources, equity based alliance is efficient since it offers better opportunities to learn tacit-knowledge and talent from the other party by tight relationship. When a firm is contributing knowledge-based resources in exchange for property-based resources, minority equity alliance is efficient since taking the equity position of the knowledge recipient partner curbs its undue use of transferred knowledge. The principle of the alliance governance choice in the above table is that the partnering firms try to balance two issues: being able to procure valuable resources from another without losing control of one's own resources, so that they can maximise the value-creating potential.

The above table shows that firm A (when we consider it as a HTSF) has to choose equity joint venture when it needs to source tacit- and knowledge-based resource from the partner. The key aim of the HTSF's technology alliance is exclusive access to and learning the partner's key resources and capability significant to the technology projects. Under this condition, the RB perspective recommends to HTSFs that having a higher level of equity ownership of the partner firm is advantageous. Joint venture is the example. Creating a single, integrated organisational structure enables smoother information flows, brings the activities to be coordinated under one source of authority and creates powerful incentives for cooperation by unifying objectives (Kale & Puranam 2004). Equity ownership-and the authority in joint venture conferring to create inter-organisational linkages-is a valuable mechanism to achieve knowledge-sharing, organisational learning, coordination and control between partners.

Of course, organisational learning is not always the ultimate goal of the technology alliance, but, the RB perspective promotes itself exclusively by this issue, assuming that the goal of strategic alliances is to acquire the knowledge of alliance partners. Learning can materialise in various forms of technology transfer between firms. Non-equity alliance such as licensing can take the place for organisational learning when the needed knowledge is explicit and property-based. However, the learning opportunity and its effect are much less in non-equity alliance because the scope and scale of the mutual involvement is limited and the explicit-and property-based knowledge are also likely to be transferable to other parties conveniently (Hennart & Reddy 1997). On the other hand, the equity alliance (i.e., joint venture) is the most instrumental among various alliance forms in the transfer and learning of the tacit and knowledge-based expertise because of the significant extent of exposure of the partnering firms and better appropriation of its partner's knowledge-based resource. Therefore, the greater the need for such inter-organisational coordination for learning and transferring knowledge, the larger the equity stake necessary.

■ Confidence based perspective

The centre of TC perspective's assumption is that different governance forms of alliance offer different degrees of control over the uncertainty surrounding partner cooperation; equity alliance is believed to provide more control than non-equity alliance by virtue of establishment of an administrative hierarchy allowing partners to exercise their residual right of control (Osborn & Baughn 1990; Pisano 1989). Therefore, control issue should be the centre of the alliance governance decision. However, this assumption is challenged by several researchers raising that control is far from a necessary consequence of equity alliance, and ownership plays only a limited role in providing control in joint venture (Casciaro 2003). For instance, equity ownership is equated to control under the assumption that more equity shares give a partner more voting power. There is no compelling argument, however, that strong a control mechanism in strategic alliance is necessarily the consequence of equity ownership (i.e., joint venture) in the inter-firm relationship (Casciaro 2003).

Equity ownership may create a mutual hostage situation helping to align the interests of all partners. However, as Casciaro (2003, 2001) argues, the mutual hostage condition may expose each partners to a different and greater level of risk (i.e., difficulty and cost of exit) due to strong commitment. In this situation, mutual hostage intensifies vulnerability to undesirable partner behaviour caused by free-riding and higher levels of alliance-specific investment. Thus, unlike the TC perspective predicted, the choice of alliance structure is not always driven and dominated by the concern of control issue; equity alliance does not always guarantee strong control power of the alliance-engaged partners.

The confidence-based perspective, notably influenced by the social network (SN) perspective, posits that the level of confidence is the antecedent of governance decision of strategic alliance, criticising that academic literature thus far has paid little attention to the role of confidence in the choice of strategic alliance mode (Das & Teng 1998). The concept of 'confidence' underscores the uncertainty aspect of cooperation; reducing the uncertainty of the partner means increasing the predictability of satisfactory cooperative behaviour. The SN perspective argues that confidence is engendered by two sources: control and trust. It maintains that, in order to access the confidence level of the alliance partners, both the control and trust issue should be simultaneously discussed as they are complementary and supplement each other. In this respect, it maintains that the TC perspective's control-based approach to the governance choice of alliance is only partially correct.

Firms use control mechanisms in alliance to make the attainment of organisational goals more predictable and to promote non-routine activities such as organisational learning, risk-taking and innovation and to prevent opportunistic behaviour (Parkhe 1993). In this study, we focus on partner control rather than alliance control since the formal is the direct source of confidence in partner cooperation. Partner control in alliance is a regulatory process by which the partner's pursuit of mutually compatible interests is made more predictable (Das & Teng 1998). Beside partner control, a certain level of inter-firm trust is indispensable for an alliance to form and function because trusted partners are able to hold a positive attitude to each other's goodwill and reliability in a risky exchange situation (Ring & Van de Ven 1992).

Trust and control are the two contributory factors of confidence in partner cooperation. However, the level of trust and control may not always be related in a strictly inverse way in which a higher trust level automatically dictates a lowering of control level and vice versa. Das & Teng (1998) summarise how control and trust influence the level of confidence in partner cooperation as in the table below.

(Table 29) Confidence level in different alliance types

		Control level	
		High	Low
Trust level	High	High confidence in partner cooperation (Joint venture)	Moderate confidence in partner cooperation (Minority equity investment)
	Low	Moderate confidence in partner cooperation (Minority equity investment)	Low confidence in partner cooperation (Non-equity alliance)

(Adapted from Das & Teng 1998)

As seen above, requisite confidence levels influence the governance form of strategic alliance. Equity alliance requires a higher level of confidence for three reasons. First, equity alliance (i.e., joint venture) requires the highest level of alliance-specific resource commitment while non-equity alliance tends to require relatively low committed resources in the relationship. Naturally, equity alliance demands a higher level of confidence in the cooperation as partners need more certainty about committing substantial resources to an alliance. Second, equity alliance invites a higher-level of inter-firm embeddedness if it is referred to the degree of mutual dependence and connectedness among the exchange partners (Provan 1993; Granovetter 1985). Third, strategic alliance is frequently referred to as a fertile area for unintended resource transfer especially technological and managerial expertise (Hamel 1991). Equity alliance is potentially most susceptible to the unintended transfer of technological know-how seen above as the partners work closely in a single organisation. No firms are willing to unintentionally transfer valuable knowledge to the partners, more so if they are less confident. Thus, only if partner firms have a fairly high level of confidence in the relationship, will they be willing to enter equity alliance.

On the contrary, when both trust and control level is low, the potential partnering firms will have lower confidence in each other and limited ability to influence each other's behaviour. This is notable in licensing agreements and supplier partnerships. When the situation is low-trust and high-control or vice versa, the confidence level will be moderate. For instance, with stringent regulation, norm and rule will offset the low-trust level that may exist between potential partnering firms, fostering weaker confidence, and improve, to a moderate level, confidence in the partner cooperation. By the same token, a sense of positive expectation of the potential partnering firms will offset a weaker control level, leading to moderately weaker confidence in the partner cooperation (Das & Teng 1998). Minority equity investment is the most likely structural choice under this situation. While holding an equity ownership position through the minority investment, the investing firm is able to monitor the partner and incremental confidence level. This helps the investing firm decide its next move: either further commitment through joint venture or acquisition, or giving up the equity share.

Seen thus far, confidence-based perspective enriches the explanation of the governance choice of strategic alliance as it is considering both the level of trust and control issue together. However, very little empirical studies have examined how the trust and control are inter-related. Some argues that trust is simply a specific type of control mechanism that governs the economic transaction while some others view that trust itself is not a control mechanism but a substitute for hierarchical control (See Madhok 1995; Ring & Van de Ven 1994).

Finding that both control and trust are inter-related and influence the confidence level in various ways as summarised above, this study argues that trust-based consideration precedes the logic of control, rather than that both are inter-related and parallel. That is because trust is already an informal control device and control comes into play only when adequate trust is not present. For instance, if a manager trusts employees to be-self-motivated to conduct the task best, no behaviour or outcome control will be needed.

Likewise, if potential alliance partners trust each other, a strict level of control mechanism at extra costs will be hindering the cooperative and friendly working environment. Indeed, the presence of trust economises the specification and implementation of control and the more trust one has, the less control one needs over a partner (Faulkner 2000; Noteboom 1996). Thus, further studies should focus on how partner trust and the source of trust will influence the governance decision of strategic alliance.

Conclusion

This chapter proposed a two-stage contingency model for technology-sourcing decision. Drawing on strategic management literature, six theoretical rationales have been reviewed to present their antecedents of technology-sourcing decision in the first stage of technology sourcing decision. The TC perspective maintains that technology-sourcing decision should be made by simultaneous consideration of management costs of in-house development and cheating costs in technology alliance, and the most efficient is chosen. The RB perspective refutes by saying that the ultimate antecedent of technology sourcing-decision is the firm's capability consideration; technologically more capable firms are more likely to form alliance and the characteristics of resources to be exchanged. The RD and MP perspectives stress the role of market condition and the levels of industry concentration and market competition as important antecedents of technology-sourcing decision. Nevertheless, they contrast their view when considering the role of the market growth as an antecedent of technology-sourcing decision. The SN perspective, on the other hand, argues that strategic alliance emerges naturally as the firm accumulates relational experiences through its various social networks. More centrally-located firms in the web of social network are more likely to form technology alliances. Lastly, the institutional perspective dictates that social pressure forces a firm to conform to generally accepted strategic behaviour, thus, the pattern of technology-sourcing decision should be understood within that context. This can be summarised in the table below.

(Table 30) Antecedents of technology-sourcing decision

Theoretical perspective	**Antecedents for decision-making in the 1st stage of decision-making**

TC perspective	•Capability for managing technology-sourcing internally •Characteristics of the transaction
RB perspective	•Characteristics of the necessary resource to be exchanged •The firm's capability (i.e., learning capability)
RD perspective	•Industry concentration level •Market growth rate
MP perspective	•Market competition level •Market growth rate
SN perspective	•The firm's centrality level within the social network
INT perspective	•Institutional pressure

Basically, strategic management literature suggests that decision-makers should consider various internal, external and technological conditions when they make technology-sourcing decision, without specifying what conditions are critically important. In this respect, this study, throughout this chapter, further elaborates on the critical conditions necessary for the decision-makers, as seen in the figure below.

(Figure 31)Antecedents of technology-sourcing decision

Antecedents of technology-sourcing decision (consideration area)		
The firm's internal condition	The firm's external condition	The technology itself
•Management capability level for internal technology sourcing •The firm's capability (i.e., learning capability)	•The firm's centrality level within the social network •Institutional pressure	•Characteristics of the transaction •Characteristics of the necessary resource to be exchanged
Antecedents of technology-sourcing decision (identified in this study)		

However, further efforts are needed to transform the above conceptual forms into measurable concepts from which working hypotheses are developed to estimate the validity of their impacts on the decision-making. Fortunately, Cho and Yu (2000) provide some guidelines on how the conceptual antecedents can be transformed into observable factors, using the examples of various previous empirical studies.

(Table 32) Cho & Yu (2000)'s literature summary (revised and modified)

Influential concepts	**Influential factors**	**Technology acquisition mode**			**Example of researchers**
		In-house R&D	R&D cooperation	Technology Purchasing	
Firm characteristics	R&D capability	High	Medium	Low	Roberts & Berry (1985), Ford (1988), Moenaert, et al. (1990), Tyler & Steensma (1995)
				High	Wilson (1977), Aurora & Gambardella (1994)
		High		Low	Lowe & Taylor (1988), Chatterji (1996)
			High		Telesio (1979), Aurora & Gambardella (1994)
		High	Low		Shan (1990), Chatterji (19900
	R&D experience	High			Nelson & Winter (1982), Pisano (1990)
		High	Low	Low	Moenaert, et al. (1990)
	History of in-house R&D	High			Nelson & Winter (1982), Pisano (1990)
Technology	History of TEP			High	Lowe & Taylor (1998)
	Technology life cycle	Earlier	Early	Later	Ford (1988)
		Interm	Early	Later	Kogut (1988), Auster (1992), Cainarca, et al. (1988)
			Early	.	Teece (1986), madhok (1997), Veuelers (1997)
		Early			Davidson & McFetridge (1985), Croiser (1998)
			Interm		Brockhoff (1991)
			Later	Later	Chiesa & Manzini (1998)
	Developing cost		High		Dodgson (1992, 1993), Radnor (1991), Tyler & Steensma (1995), Croiser (1998)
		Med	High	Low	Hamel, et al. (1989)
	Need for standardisation		High		Harrigan (1988), Bailetti & Callahan (1993)
		Low	High	Med	Riedle (1989), Oliver (1990)
	Uncertainty	High			Baughn & Osborn (1990)
		High	High		Levy (1985), Walker & Webber (1987), Mahoney (1992)
		Interm	High	Low	Hamel, et al (1989), Dodgson (1992)
		Low		High	Lowe & Taylor (1998),

			HIgh		Veugelers (1997), Chiesa & Manzini (1998)
			Interm		Lierena & Wolf (1994)
Enviro nment	Appropri ation regime	Tight			Spence (1984), Teece (1986), Ouchi & Bolton (1988)
			Tight	Tight	Croiser (1998)
		Loose	Tight		Chiesa & Manzini (1998)
	Market size	Med	Large	Small	Rosenbloom & Cusumano (1987)
	Extent of competit ion	Hostile	Not-Ho	Not-Ho	Pisano (1990)
		Med	Hostile	Not-Ho	Perrino & Ripping (1989),
			Hostile		Shan (1990)
				Hostile	Lowe & Taylor (1998)

In addition, Varadarajan and Cunningham (1995) provided lists of identifiable factors related to firm-, industry- and environmental characteristics influencing the propensity of a firm to enter into strategic alliance.

Using the above literature summary and Varadarahan and Cunningham's 1995 study as a reference, this study argues that the top management would consider four aspects of the internal condition, namely: (technological capability, previous R&D experience in a relevant area, previous experience of in-house development and entrepreneurial strategic orientation); three aspects of the environmental condition: (environmental uncertainty, market growth, pressure to pursue technology cooperative strategy (legitimacy of technology alliance); and, finally, three aspects of technology development projects: (level of asset specificity, life cycle phase of technology and technology uncertainty). The next chapter will elaborate how these are derived, and working hypotheses will be provided in detail.

Three theoretical rationales have been reviewed, suggesting key antecedents of the second stage of the technology-sourcing decision-making. The TC perspective deploys a similar logic used in the first stage of decision-making; stabilising the transaction with the potential partner from 'hold-up' hazard, unfair sharing and opportunism should be the key consideration in structuring technology alliance. In doing so, it stressed the significant role of ownership and control. The RB perspective argues that the focus of structuring technology alliance is to identify the best method of exchanging the valuable resources between partners and learning from them. In this respect, the attributes of resources to be exchanged should be analysed for the decision. Lastly, the confidence-based perspective refutes that the TC theory's control-based approach is partially correct at best, as it ignores the fact that partner trust mitigates the impact of relational hazard in technology-sourcing decision. Thus, building and assessing partner trust should be the key consideration area in the second stage.

In this chapter, we have found that technology sourcing-decision is never simple logic. We have reviewed various antecedents and predictions from multiple theoretical perspectives, and no theoretical explanation is superior to any other; each may provide valuable insight in its own right. On the other hand, we found that the boundary of each theoretical logic may not always be unique and distinctive. In some cases, common ground is apparent in explaining the fundamental logic, while others show contrasting views. Obviously, the integration of various approaches should beapplied out in this situation. This is possibly achieved by identifying antecedents that are mutually exclusive from various perspectives, and ones that are shared by various perspectives but which have contrasting impact on the technology-sourcing decision. The next chapter will elaborate conceptual antecedents summarised in this chapter into observable factors from which testable hypotheses are generated to test their validity.

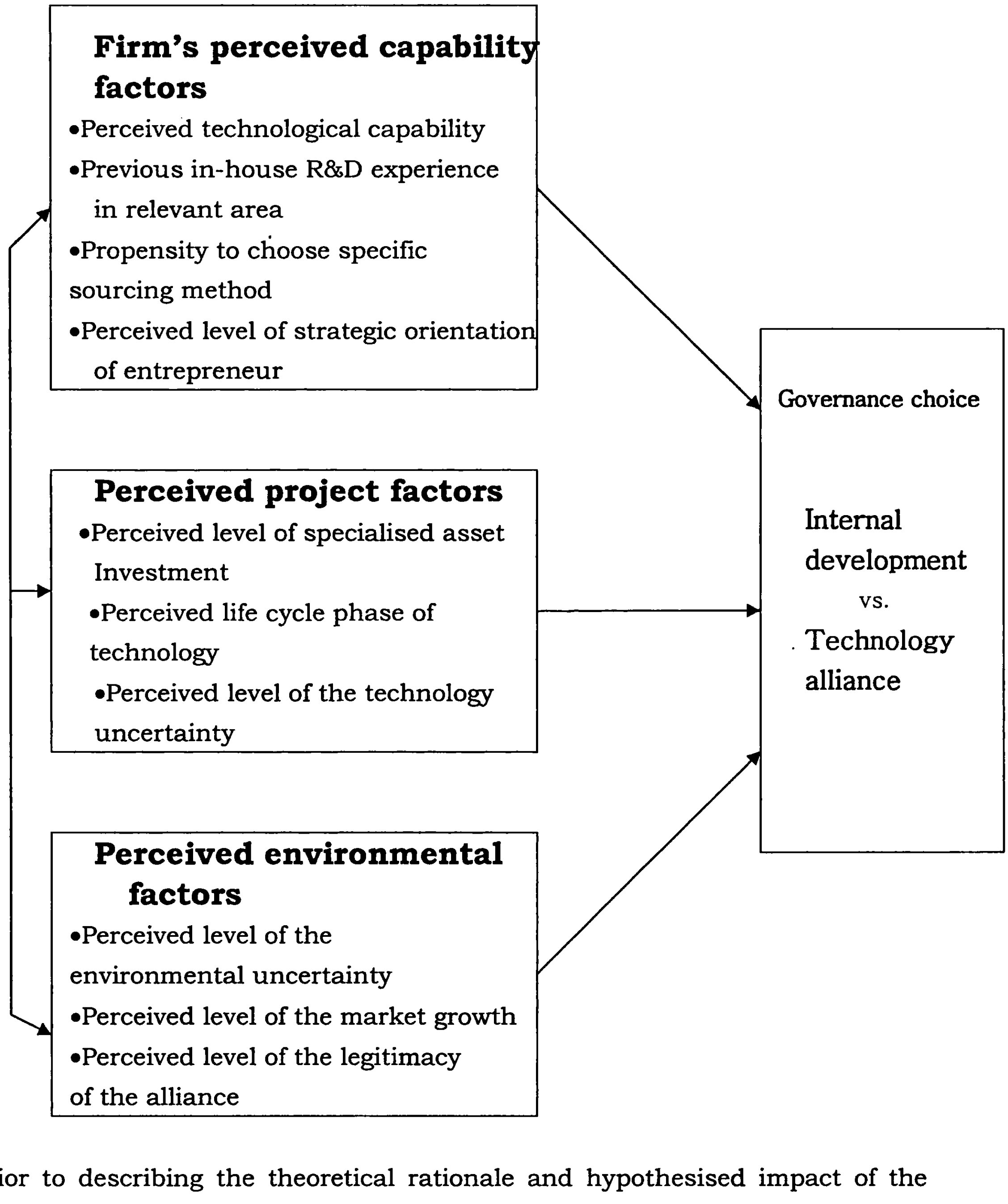
Chapter 5: Research framework and hypotheses

Introduction

This chapter will elaborate the antecedents not defined in measurable form in the previous chapter into measurable working hypotheses to test their validity in the next chapters. Based on the two-stage contingency model and relevant literature review in the Chapter 4, this study argues that, in the first phase of decision-making, the top management of HTSFs assesses its perception on the firm's internal capability (technological capability, previous R&D experience in a relevant area, previous experience of in-house development and entrepreneurial strategic orientation), environmental conditions (environmental uncertainty, market growth, pressure to pursue technology cooperative strategy (legitimacy of technology alliance)) and characteristics of technology (level of asset specificity, life cycle phase of technology and technology uncertainty) which it is intended to develop in order to come up with a solid plan for the new technology development project. Figure 5 visualises the relationship of these aspects and the next section will describe how the first stage of the decision-making process is simultaneously affected by them.

5.1 Hypotheses in the first phase of decision-making (stage one)

(Figure 5) Determinants of decision making in the first stage



Prior to describing the theoretical rationale and hypothesised impact of the above 10 variables, a summary of the final hypotheses is presented first below. All hypotheses try to express how the decision-makers' perceived level of the suggested factors by the time they initiated the technology project have lead them into the final decision.

	Hypotheses	theoretical base of the prediction
H1-1	**(Perceived level of technological capability)** Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the decision-makers of Korean high-tech small firms **will choose in-house development** for new technology development project	TC
	Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the decision-makers of Korean high-tech small firms **will choose technology alliance** for new technology development project	RB, SN
H1-2	**(Proportion of R&D workers)** Ceteris paribus, the greater the proportion of R&D workers within the firm, the more likely that the decision-makers of Korean high-tech small firms **will choose in-house development** for new technology development project	TC
	Ceteris paribus, the greater the proportion of R&D workers within the firm, the more likely that the decision-makers of Korean high-tech small firms **will choose technology alliance** for new technology development project	RB
H1-3	**(Previous in-house R&D experience in relevant area)** Ceteris paribus, the more previous internal R&D experience in similar area, it is more likely that the decision-makers of Korean high-tech small firms **will choose in-house development** for new technology development project	TC, RB
H1-4	**(Propensity to choose specific technology sourcing mode (routine response))** Ceteris paribus, the more often the decision-makers of Korean high-tech small firms choose in-house development for new technology development previously, the greater the likelihood that they **will choose the same method over again**	TC, RB, INT
H1-5	**(Perceived level of strategic orientation of entrepreneur (entrepreneurial orientation)** Ceteris paribus, the greater the level of the entrepreneurial strategic orientation that the decision-makers of Korean high-tech small firm have, the greater the likelihood that they **will choose technology alliance** for new technology development project	RB, SN
H1-6	**Perceived level of specialised asset investment (Technology/product specific asset)** Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makers of Korean high-tech small firms **will choose in-house development** for new technology development project	TC
	Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makes of Korean high-tech small firms **will choose technology alliance** for new technology development project.	RB

H1-7	**(Perceived phase of the technology life cycle (stage in technology life cycle)** Ceteris paribus, as the perceived phase of technology life cycle reaches the mature stage, the decision-makers of Korean high-tech small firms will **choose in-house development** for new technology development project.	RB
	Ceteris paribus, as the perceived phase of technology life cycle reaches the mature stage, the decision-makes of Korean high-tech small firms will **choose technology** alliance for new technology development project	TC
H1-8	**(Perceived level of the technology uncertainty)** Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose in-house development** for new technology development project	TC
	Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose technology alliance** for new technology development project	MP
H1-9	**(Perceived level of the environmental uncertainty)** Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the decision-makes of Korean high-tech small firm **will choose in-house development** for new technology development project	TC
	Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the decision-makers of high-tech small firms **will choose technology alliance** for new technology project	MP, RB
H1-10	**(Perceived level of the market growth)** Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose in-house development** for the new technology development project	RD
	Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose technology alliance** for new technology development project	MP
H1-11	**(Perceived level of the legitimacy of the alliance)** Ceteris paribus, the greater the perceived level of legitimacy of the alliance (pressure pushing firm to pursue cooperative strategy), the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose technology alliance** for new technology development project.	IST

(TC: transaction cost perspective; RB: resource based perspective; RD: resource dependence perspective; MP: market power perspective; IST: institutional perspective)

! Firm's perceived capability factors and technology-sourcing decisions

In the previous chapter, we saw that several perspectives point out that a firm's internal capability influences its technology-sourcing decision.

However, these perspectives define the internal capability of a firm and its impact in quite different ways. For instance, the transaction cost (TC) perspective views it as a firm's ability to minimise the transaction costs associated with an activity (Williamson 1985). The resource based (RB) perspective views it as an ability to minimise the production costs associated with an activity[6]. The social network (SN) perspective and institutional perspective both stress the firm's previous experience as a significant underlying source of internal capability influencing the technology-sourcing decision.

A firm's internal capability is a multifaceted theoretical notion; various theories shed light on different dimensions and there is no one standardised way of quantifying it either. Their implication for technology-souring decisions depends on how one defines it from which theoretical perspectives. Based on various perspectives, this study suggests that following five observable factors constitute important sources of a firm's internal capability.

Perceived level of the technological capability of a firm

As stated previously, both the TC perspective and RB perspective stress the impact of organisational capability on technology-sourcing decisions. However, their predictions contrast. TC perspective recommends hierarchical in-house development for technology projects if the firm possesses strong organisational capability, while the RB perspective recommends external sourcing methods for firms with strong organisational capability. However, the two highlight different dimensions of organisational capability: the TC perspective focuses on the firm's efficiency in hierarchical management and administrative control while the RB perspective focuses on the firm's ability to create value-maximising potential based on its absorptive and learning capacity. One may say that the former is subsumed into the latter or vice versa. This study argues that the basis of the various dimensions of organisational capability emphasised by the TC and RB perspectives is technological capability, at least for the purposes of the present work. Using the technological capability of a firm as an observable factor in its

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[6] According to Lei (1997), a firm's ability to minimise production costs indicates the firm's ability to evaluate acquire, assimilate, integrate diffuse, deploy and exploit knowledge to perform basic or advanced functional activities better than competitors, utilising a set of resources including skills, knowledge and human capital.

organisational capability, we can examine which theoretical prediction is more significant within the context of this study.

Technological capability is the ability of a firm to develop innovative new products by improving its manufacturing process or by differentiating its products from those of competitors, lowering production costs and improving product quality (Kotabe & Swan 1996). Technological capability is not, however, limited to the innovative capability of the firm's R&D units. Rather, the firm must integrate the capabilities of its functional units, such as R&D, marketing, manufacturing and finance, as technological development requires the integration (combination and interaction) of a wide diversity of specialised knowledge and skills held by individuals and groups of individuals in various functional units without communication constraints (Grant 2002). On the other hand, technological capability indicates a firm's ability to exploit outside sources of knowledge critical to innovation, based on the firm's absorptive capacity and learning. In this respect, a firm can be called technologically capable only when it possesses the internal management skills necessary for such integration, functional capability, and a high capacity to absorb, evaluate and utilise outside knowledge (Verona 1999).

As stated previously, the TC perspective predicts that the decision-makers will consider the relative benefits of each technology-sourcing mode by comparing internal transaction costs (management costs) and external transaction costs when making technology sourcing-decisions, and will choose the most cost effective mode. However, as mentioned earlier, decision-makers face a hard time estimating the relative and comparative benefits/costs of each technology-sourcing mode. Therefore, for simplicity's sake, this study assumes that the decision-makers of Korean HTSFs estimate the relative transaction costs of in-house development as a priori for conducting technology projects. After all, all other things being equal, going it alone is the best way to capitalise on their R&D efforts and maximise returns on investment without sharing it with potential partners. On this basis, the TC perspective suggests that if firms have built a strong in-house capability to carry out projects with low management costs, they have no need to get involved in the messy business of agreeing a contract with another firm and thus incurring extra costs (Demsetz 1988).

According to the TC perspective, technologically capable Korean HTSFs should choose in-house development over external sourcing. Carrying out new technology projects internally demands superior administrative control and management capability. Undertaking the project requires organisational principle, mutual adjustment of knowledge and establishment of routines, all of which help coordinate new technology projects internally with minimum management costs (Poppo & Zenger 1998). The task team internally assigned to the project should be designed to accommodate these requirements, otherwise the hierarchy will be too rigid and mechanical, which in turn results in 'not-invented-here' syndrome or shirking behaviour, leading to higher management costs. The firm and its subordinate (task team) should have standard operating procedures and a command structure, which includes planning, rules, programmes and procedures; this formal and standardised control minimises communication between necessary business units, simplifies the decision-making and uncertainty, and prevents disputes. Firms become technologically capable because they possess a strong capacity to manage such task teams efficiently. Thus, these firms have no need to enter into interfirm relationships, at extra cost, to carry out future technology projects. The more technologically capable Korean high-tech small firms are, the better they can carry out such projects internally.

The RB perspective comes to starkly different conclusions, predicting that technologically capable firms are more likely to engage in external sourcing for technology projects because they have a strong capacity to absorb external knowledge. The aim of a new technology project is to complement and supplement the firm's existing innovative assets and, thus, create further value potential. To make this happen, a firm should be continuously learning from and acquiring new sources of knowledge, outside the firm, which are related to the firm's existing technological capability (Lei 1997). The fact that a firm possesses a well-developed technological capability indicates that it is better able to understand, learn from, absorb and apply the new technological capability, gained outside the firm, to enhance its underlying competence, than a firm that lacks a similarly developed competence or capacity to learn (Cohen & Levinthal 1990).

The RB perspective posits that absorptive and learning capability (technological capability) are the essential determinants of technology-sourcing decisions: technologically strong firms are those who have strong absorptive and learning capability, thus, they are more likely to choose external sourcing methods for technology projects. Valuable knowledge, necessary to the technology project, tends to be tacit and socially complex, with multiple interactive components, and they tend to be external knowledge (Kogut & Zander 1992). Technologically strong firms are better able to recognise the value of such external knowledge and successfully commercialise it (Cohen & Levinthal 1990). However, learning from a distance is inefficient because it is difficult to transfer knowledge. If firms have absorptive and learning capability, forming technology cooperation will be a huge advantage to them because they will be able to conveniently and effectively transfer the external knowledge better than any others. If Korean HTSFs possess such capabilities, it will be better off choosing external sourcing methods for new technology projects.

The social network (SN) perspective supports the predictions of the RB perspective. According to it, technologically capable firms are those who are located at the centre of their existing social network, having technological prestige, information-rich, high-social status and better-access to reliable information and new adventure by their existing portfolio ties. In addition, technologically capable firms are attracted to other capable firms: their strengths in one area enable them, through collaboration, to create value in other areas, while each can complement the partner's strength in its own area of competence (Sen & Egelhoff 2000). On the other hand, located at the centre of their social network, the technologically capable firms are much less hesitant to choose technology cooperation as they are able to conveniently search and screen potential partners without incurring high costs. Centrally located firms within their the social network do not lead themselves to favour technology alliance automatically under any circumstance, but the chances are likely to increase because they are able to examine the feasibility of both technology alliance and in-house development equally and more carefully.

In summary, viewing technological capability as an observable factor in organisational capability, the TC and RB/SN perspectives make different recommendations on technology-sourcing decisions. The former suggests that technologically strong firms become strongly competitive because they have accumulated the internal management skills to carry out innovation activities internally. Thus, internalising the new technology project is much more efficient for them in most cases. The latter claims that technologically capable firms become strongly competitive because they have accumulated the capacity to absorb new knowledge, and at the same time they take advantage of their status and search for an equally capable partner efficiently. Thus, cooperation with another firm in new technology projects will create more value than going it alone. Based on these powerful contradictions, this study proposes hypotheses to test that:

H1-1: Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project
Or
H1-1: Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development project

Whereas perceived technological capability is a subjective evaluation of organisational capability, this study proposes that the proportion of R&D workers within the firm is also a good indicator of accessing the technological capability of Korean high-tech small firms. Using this as another operative variable of the firms' perceived level of technological capability, this study proposes hypotheses to test that:

H1-2: Ceteris paribus, the greater the proportion of R&D workers within the firm, the more likely that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project
Or
H1-2: Ceteris paribus, the greater the proportion of R&D workers within the firm, the more likely that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development project

Previous in-house R&D experience in relevant area

The TC perspective argues that previous internal R&D experience in relevant areas is the significant factor determining internal production costs, which, in turn, influences technology-sourcing decisions. In the case of vertical value chain of the manufacturing industry, the TC perspective maintains that the prior experience of a buyer decreases the supplier's production cost advantage over the buyer, rendering 'make' decisions more attractive to the buyer (Walker & Webber 1984). Similarly, previous R&D experience in a related technological area can decrease not only the internal management costs but also internal production costs of the new technology project because the firm has information about how to manufacture/design relevant components and how to organise project teams efficiently. Familiarity reduces across the board the costs of carrying out a new project. In this case, the firm is best-off adopting internal development over other options, since the required expertise already exists within the firm, helping to reduce the time required to make a profit. In short, if a firm has experience of internal R&D in a similar area, new technology projects involve less management and lower transaction costs than for inexperienced firms, leading them to choose internal development (Brockhoff 1992).

As the RB perspective posits, analysing a firm's capability is important before making technology-sourcing decisions (White 2000). It is generally hard to analyse a firm's present capability without understanding its past: organisational capability is not created out of a vacuum. The firm's existing technological resources and capability derive from its accumulated experience in design, production, problem-solving and trouble-shooting. Every firm possesses a unique history of progressive accumulation of technical knowledge. Therefore, just like any other capability, the existing stock of technology is history-dependent and constrains the firm's future technological development – what the firm can hope to do technologically in the future is heavily constrained by what it was capable of doing in the past (Tsang 1997). In this respect, a firm's assessment of its capability should reflect its previous experience, which, at the same time, influences its technology-sourcing decisions in the future. This is the assumption of RB perspective, which predicts that if the firm's technology project is closely related to prior internal R&D in a similar area that outsiders cannot easily understand, going it alone is more efficient (Nelson & Winter 1982).

Some authors recommend that, to maximise performance, small firms should stick to areas related to the firm's base business (Roberts & Berry 1985). Many HTSFs concentrate on one key technological area and introduce product enhancements related to that area. When a new project is highly related to the firm's previous in-house efforts, it is automatically constrained and guided by the firm's past learning, experience and specialisms (Lei 1997). In this case, externalising the transaction (the project) will generate less value because the partner needs time to understand the firm's opaque and idiosyncratic past experience. Given different firm history and path dependence, this will be a slow, costly and at best imperfect process. The value created will likely be less than the sourcing partners expected. In addition, the firm can benefit from a greater 'learning curve' when it carries out a project related to its past experience internally (Pisano 1990).

Following the predictions of the TC and RB perspectives, this study assumes that, all other things being equal, Korean HTSFs will internalise the new technology project if it is closely related to their previous R&D experience in relevant areas. Chapter 3 (pp.67) illustrated that the innovation activities of many Korean HTSFs has been focused on modifying or improving previously existing products. In-house development offers advantages in such cases. For instance, such firms have already accumulated experience in running projects from their own internal language, and can thus avoid the potential difficulties of persuading the other party about expenditure, knowledge input, and marketing and sales. Previous experience in a relevant technological area lowers production and transaction costs within the new technology development project as well. In such cases, hierarchical control via internalisation better enables the firm to create added value with smoother information and communication flows. Therefore, the present study hypothesises that:

H1-3: Ceteris paribus, the more previous internal R&D experience in similar area, it is more likely that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project

Propensity to choose specific technology-sourcing modes (routine response)

This section deploys a rationale similar to that in the previous section (previous in-house R&D experience in relevant area). Firms may be reliant on certain types of governance choice that may not always best suit them. This is because the firm's previous pattern of technology-sourcing can affect its present procurement methods. For instance, a continued dependence on joint development may deter managers from developing their own firm's capabilities, and allow partners to appropriate competitive skills together (Hamel, Doz & Prahalad 1989). Other firms may insist on internalisation or acquisition because the management feels uncomfortable giving up total control and therefore rejects strategic alliance (Steensma & Fairbank 1999). As the RB perspective stated in the Chapter 4, organisations may be history-dependent; future strategic decision-making is partially dictated by past behaviour (Collis 1991). Over time and with experience, HTSFs may generate a technology-sourcing method that successfully exploits technological know-how either through joint development or in-house development, and thus dismiss alternative sourcing modes.

Why do firms become dependent on a particular strategic mode? The TC perspective proposes that firms tend to rely on past governance methods since repeated use of a specific governance mode decreases transaction costs of that use. The RB and Institutional perspectives suggest that firms tend to find routine ways of doing things, and are likely to behave in the future in accordance with the routines adopted in the past (Nelson & Winter 1982). Thus, irrespective of the efficacy of the technology development mode influencing immediate performance, the firm's previous pattern of technology-sourcing affects its present choice (Steensma & Fairbank 1999; Pisano 1990).

A detailed description of this phenomenon can be found in Prahalad and Bettis (1986). They explain that managers tend to process organisational events through a pre-existing knowledge system, known as a 'schema', which represents beliefs and theories developed through previous experience. Through this schema, managers are able to scan various actions and the environment selectively, helping them make timely and efficient decisions, although a manager's schema is not always an infallible guide to an organisation. Such schemas become the conventional wisdom or dominant management logic. Firms (i.e., decision-makers) thus develop a particular mind-set (comfort zone) and a repertoire of preferred tools and processes, which determine the approach likely to be used in new product development. If previous practices, strategic behaviour and approach are successful, they are likely to persist for a long time, even though they may be inappropriate in present circumstances. Several data indicate that a firm's strategic decision-making tends to be history-dependent. For instance, Arthur D. Little Co. reported that firms with a long history of success in internal R&D often stick with this approach when investing resources in subsequent technology development projects (Kurokawa 1997).

This study assumes that Korean HTSFs develop a tendency to make the same technology-sourcing decision again and again, irrespective of its efficacy. The firm may be uncomfortable with modes with which it has less organisational experience. Interviews with some R&D managers of Korean HTSFs reveal that they tend to stick to familiar governance methods, emphasising that this approach makes them feel safer with one decision over other one because it simplifies cost-benefit analysis: having analysed the selected option, they can ignore other options.

H1-4: Ceteris paribus, the more often the decision-makers of Korean high-tech small firms choose in-house development for new technology development previously, the greater the likelihood that they will choose the same method over again

Perceived level of strategic orientation of the entrepreneur (entrepreneurial orientation)

Unlike the TC perspective, assuming that entrepreneur's function is to coordinate production within the firm by fiat, the RB perspective views him/her as an innovator and wealth creator (Tsang 2000). The RB perspective, however, stresses that entrepreneurial skills such as the entrepreneur's aspiration, vision and previous employment should be included in the analysis of the firm's capability consideration. Unfortunately, the RB perspective fails to further specify what aspects of entrepreneurial skills are critical in the firm's capability analysis and how it is influential in the technology-sourcing decision. Most often, a small firm's capability tends to be limited by the owner-entrepreneur's socio-economic background and this has the greatest influence on the firm's direction (Yu 2001). Many studies find that the small firm's strategy, structure and performance are better understood through examining the behaviour of the entrepreneur (i.e. owner or founder) than environmental factors (Lee & Tsang 2001). In light of this, this study proposes that the entrepreneurial strategic orientation (as an aspect of the entrepreneur's character) has a major impact on technology-sourcing decisions.

Chandler and Hank (1994) argue that the small entrepreneurial firm is the extension of the founder: everything revolves around the entrepreneur; the firm's goal is his/her goal and its strategy is his/her vision of its place in the world. The personal traits, demographic characteristics, educational experience, networking competence and leadership skills of the entrepreneur shape how he/she scans the firm's environment, selects promising opportunities and formulates strategies to take advantage of these opportunities (Chandler & Hanks 1994). This is the classic role of the entrepreneur. It is crucial to an organisation's internal capability, which directly impacts on the firm's performance. Entrepreneurship comprises sets of organisational behaviour that initiate and manage value creation in novel ways by introducing new products or methods of production into the market, opening new markets for output, discovering new sources of material and creating new forms of industrial organisation (Heron & Robinson Jr. 1993; Schumpeter 1934). Some authors have found a positive relation between entrepreneurship and organisational performance (McCarthy 2003); the relation between the founder's entrepreneurship and competitive strategy is not however substantiated in the literature [7].

An entrepreneurial strategic orientation reflects a firm's overall strategic posture, that is, the extent to which the founder or decision-maker is inclined to take business-related risks, to favour change and innovation in order to obtain a competitive advantage and to aggressively compete with other firms (Covin, et al. 1990). Scholars of entrepreneurship suggest that an entrepreneurial strategic orientation can drive a firm to adopt certain organisational processes, methods, and styles to implement the start-up's founding strategy (Lee, et al. 2001). McCarthy (2003) argues that small firms' strategic formation is not simply an exercise in rationality but is informal in the sense that the strategy is not written down but resides in the minds of CEOs. He continues that entrepreneurs are not only strategists who focus on the long term and act according to rational principles, but are also instinctive, intuitive and impulsive strategists. These scholars point out that different types of entrepreneurs, either rational or intuitive, are likely to pursue different types of strategy or strategic priority.

The types of entrepreneur are multidimensional and complex; they can be summarised in terms of binary pairs such as charismatic vs. pragmatic, visionary vs. plan-focussed, creative vs. reactive, intuitive vs. rational, etc. In general, scholars point out that three factors are essential in defining

[7] For further study, please refer to McCarthy (2003) and Zahra (1993).

entrepreneur type: innovation, risk-taking behaviour and proactiveness (Lee, et al. 2001). Using these components, they classify two distinctive types of entrepreneur in their attempt to link the entrepreneur types to the strategies pursued by them: entrepreneurial vs. conservative. The strategic orientation of entrepreneurial type is more likely to take a strategic approach to innovation, risk-taking and proactiveness; he or she is willing to commit resources to uncertain and novel businesses, and engage in "first mover" action such as the introduction of new products/services ahead of competitors (Lee, et al. 2001; Miller & Friesen 1982). In contrast, the strategic orientation of the conservative type tends to be risk-averse, non-innovative and reactive; he or she innovates only when the firm is seriously challenged by competitors or by shifting customer demands. There is no conclusive evidence in general terms that the entrepreneurial type is superior to the conservative type or vice versa. A small firm's strategic orientation can be placed on a continuum between entrepreneurial and conservative. A firm's propensity to choose a competitive strategy may vary according to its place on the continuum.

This study proposes that a firm's technology-sourcing decisions differ according to the strategic orientation of the entrepreneur. Specifically, this study assumes that HTSFs with more entrepreneurial strategic orientation (more innovative, risk-taking and proactive) are more likely to enter into a greater number and variety of inter-firm relationships than firms with less entrepreneurially oriented. Marino, et al. (2002) support this assumption by showing that Indian entrepreneurs displaying high levels of pioneering, innovation and risk-taking were more likely to build a variety of alliances including, but not limited to, R&D, financing and market access. Entrepreneurial firms' risk-taking propensity naturally makes them hedge against risks by forming multiple networks in which potential alliance partners may be included. Multiple networking systematically reduces their exposure to unnecessary risks by providing flexibility in planning and the ability to capitalise on unexpected changes in the external environment.

As seen in the previous chapter, the SN perspective contends that a firm's external embeddedness is a potential source of entrepreneurial profit and value creation: the source of innovation does not always reside inside firms but is often inherent in the interstices between firms, universities, laboratories, suppliers and customers (Sarkar, et al. 2001). Studies found that entrepreneurial firms are those whose entrepereneurs actively seek and scan for opportunities in the external environment and interstices between various economic players, and they frame seemingly risky and uncertain opportunities found from interstices in a positive light (Stuart 1998; Miller & Friesen 1982). They tend to seize these new opportunities by taking pre-emptive action in contrast to the conservative firms. In doing this, the role of strategic alliance is immense. The key to the entrepreneurial firms that they are highly external embedded; they are involved in multiple and compels networking relationships through which they are better able to identify and exploiting value-creating opportunities existing interstices of the various players than conservative firms (Dickson & Weaver 1997; Miller & Friesen 1982). They more often form the alliance because doing so will enable these firms to gain the competitive intelligence necessary to identify opportunities in the external environment and provide multiple lines of inquiry into the external environment.

The present work extends this logic and thus assumes that Korean HTSFs with more entrepreneurial strategic orientation form more alliances, because they provide valuable resources and multiple lines of inquiry into the external environment and allowing them to exploit new opportunities. Therefore, the hypothesis is that:

H1-5: Ceteris paribus, the greater the level of the entrepreneurial strategic orientation that the decision-makers of Korean high-tech small firm have, the greater the likelihood that they will choose technology alliance for new technology development project

! Perceived project factors (project attributes) and technology-sourcing decisions

As previously stated, both the transaction cost (TC) and resource based (RB) perspective maintain that the characteristics of the new technology project in terms of its transaction and value creation aspects influence how to undertake the project. If no firm can perfectly source competitive technological resources necessary to the project internally because of bounded rationality (limited organisational capability), the firm has no choice but source them from external actors in the various industries. However, in this case, the market for crucial inputs is not always well-established because such resources are difficult to define, specify and trade and are highly tacit in nature (Schilling & Steensma 2002; Narula 2001; Chi 1994). Therefore, relying on external sources for crucial resources may not always work as the firm expects. The TC and RB perspectives make contrasting predictions and sourcing recommendations under such conditions.

The TC perspective focuses on the cost aspects of the transaction that may occur in executing the project. Carrying out competitive technology projects is extremely costly because the outcome is inherently highly uncertain and because they require dedicated investment. The contract cannot cover all possible contingencies, which in turn leads to opportunism and cheating among partners and damages the relationship. The RB perspective meanwhile views the transaction (project) as a process of creating unique and competitive resources that do not exist within the firm's existing knowledge (Chi 1994). The transaction also requires highly transaction-specific and investment-specific inputs that are inimitable and immobile from the spot market. Thus, from the RB point of view, where crucial resources are not perfectly available inside the firm and proximity to such sources is necessary, close interaction with other firms makes a lot of sense, in order to create further value.

In fact, creating valuable resources and incurring transaction costs in new technology projects are two sides of the same coin: valuable resources should be exchanged to create further valuable resources but such resources cannot be exchanged without incurring high transaction costs due to asset specificity and rarity. In this sense, both the TC and RB perspective have their own rationale: they see other side of the same coin, giving contrasting views. However, their explanatory power may not be equal. To test this, it is necessary to identify observable elements of the technology project that give rise simultaneously to high-transaction costs and value-creating potential. This study proposes that the decision-maker's perceived level of specialised asset investment, the phase of the technology life cycle and the technology uncertainty embedded in the new technology project are key determinants of the project and the source of variation in terms of its transaction costs and value creation.

Perceived level of specialised asset investment (Technology/product specific asset)

Developing new technology always necessitates specialised investment or the involvement of physical, technological and human assets. HTSFs may have to procure specific resources through the most efficient governance modes, such as mergers and acquisitions, strategic alliance or internalisation. Specific investment could be in plants and equipment (tangible assets) or operating procedures, brand name capital or knowledge and expertise (intangible asset). Within the context of new technology projects, asset specificity refers to the transferability of assets from one use to another. Specific assets are those whose value is less if switched to alternative transactions and consequently whose value is not fully salvageable (Young-Yabarra & Wiersema 1999). In high-tech industries specific investment is mostly likely to be in knowledge-specific assets such as specialised human knowledge and technological experience. Since these are specifically tailored to developing a particular technology project, they may be considerably less valuable if applied or redeployed outside the project (Heide & John 1990). Given this aspect, the TC and RB perspectives argue that perceived level of specialised asset investment influences the final decision, but in opposing ways.

The TC perspective argues that the firm will be better off internalising rather than collaborating when it has to make investment-specific transactions (firm-specific and tacit investment in the project) because investment-specific transaction is characterised by a small number of bargaining hazards (Robertson & Gatignon 1998; Williamson 1985). It is obvious for HTSFs that technology projects, for competitive advantage, are likely to require investment specific to the transaction in the form of plant, equipment, brand name and experience, and, at the same time, require complementary contribution from other firms. However, it is not convenient to find the source of complementary contribution fitting to the specification of the project from other firms, if any, if only a limited number of other firms are available to supply such resources essential to the technology innovation project.

Under this condition, forming relationships with them for investment-specific projects causes a small number of bargaining hazards. It refers to the situation where a partner with limited exchange alternatives in required to invest in transaction-specific assets, and is, therefore, locked into this relationship. This may subject them to the exploitation of the partner. In this case, the stronger partner may behave opportunistically, demanding excessive rents and stringing out the contract and monitoring, so that the weaker partner (more likely to be a small firm) has little alternative but to lock-in the relationship and accommodate the special needs of the powerful partner (Schilling & Steensma 2002). To prevent such problems, the TC perspective asserts that in-house development is a better option when the firm has to make specialised asset investment in the project.

The RB perspective differs. Through the new technology project, the firm wishes to increase the Ricardian rent. The key to Ricardian rent is the presence of scarce resources which generate higher profits than other resources of the same type (Rumelt 1987). To maximise the Ricardian rent, the firm must make the most of and its superior technological resource through the technology project. To do this, the firm has to make firm-specific, commitment and the best asset investment for the technology project. As presented in the previous chapter, the RB perspective assumes that pure internalisation and acquisition of the other firm are already ruled out as the optimal choices for maximising the Ricardian rent, due to bounded rationality (no firms are perfectly capable of doing anything alone) and inefficiency (buying the whole for its part by paying substantial price premium is not rational). Hybrid organisations such as joint ventures are perfectly appropriate in such cases because this will complement the firm's existing superior, specific and committed technological resource invested for the project most effectively.

Why is Ricardian rent best achieved through technology alliance? The basis of the RB logic is that two firms combining valuable and specialised resources together will maximise the size of the rent pool together (Tang 2000). The following example will clarify this logic. For instance, firm A has strong capability in designing new semiconductors while firm B has a strong production capability in a similar industry. Each of them is very firm-specific, so that they cannot transact in the market. When the two strong capabilities are used separately, The Ricardian rent won't be generated. Ricardian rent will be generated when these capabilities are combined together in manufacturing new semiconductors. As argued, setting up technology alliance can be the best option in order for both firms to reap the rents created; close and intimate interaction will diminish the small-number bargaining hazard because both partners know that the synergy created together will be larger than that created individually or opportunistically (Madhok 1996). Thus, RB perspective argues that when a firm is trying to invest its best assets (specialised asset investment) to maximise Ricardian rent, cooperation with another firm will create further value.

Both theoretical perspectives are relevant to technology-sourcing decision among Korean HTSFs. In many cases, such firms have to invest in customising the technology for their own use (increasing the level of investment-specific assets), thus making the project unique. At the same time, they have to engage with other firms to supplement their insufficiencies. There are often a limited number of players in the marketplace capable of providing HTSFs with the state-of-the-art technology necessary for their technological innovation projects. In this case, the small firms are exposed to greater contractual hazards when they collaborate with one of this very limited number of players. The potential partner knows that the small firms have made asset-specific investment in the project, which will have less value if used in another context. The potential partner will have an incentive to appropriate returns by threatening post-contractual bargaining and contract termination (Poppo & Zenger 1998; Williamson 1985). In such cases, the TC perspective warns that any engagement with another firm may involve many risks.

On the other hand, the RB perspective also has a strong basis. Cooperation facilitates synergy and Ricardian rent, precisely what HTSFs are hoping to gain from the technology project. Hold-up or bargaining-hazard problems may not put these firms off, because they are unable to achieve these ambitious goals alone. Considering their limited individual knowledge resources and capabilities, external sourcing is a better choice. To examine two contrasting perspectives, this study hypothesises that:

H1-6: Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project
Or

H1-6: Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makes of Korean high-tech small firms will choose technology alliance for new technology development project.

Perceived phase of the technology life cycle (stage in technology life cycle)

Cainarca, et al (1992) divides the technology life cycle into introduction, early development, full development, maturity and decline, while Robert and Liu (2001) talk of a fluid, transitional, mature and discontinuity phase [8]. All technology projects have the same goal: achieving competitive advantage and increased profits of a firm. However, their content may differ depending on where the developing technology is located in the technology's life cycle, making each project unique. Increasingly, the challenge for managers is to recognise where new technology development fits within the technology life cycle and decide what kind of technology-sourcing method is most likely to accelerate development (Roberts & Liu 2001).

However, classifying the life cycle phase of technology may be more theoretically stimulating than empirically compelling. Some scholars therefore roughly estimate the stage in the technology life cycle on the basis of the R&D type that a firm is working on. For instance, R&D activities including basic research, applied research, experimental development, product design and testing are treated as representative of each stage of the technology life cycle. Brockhoff (1991) examines the relationship between R&D type and technology life cycle, using 135 large German manufacturing firms. He finds that basic and applied research occurs mainly in the early and later stages of the technology life cycle, while development and construction engineering (experimental development, design and testing) tends to occur in the intermediate stage.

The TC perspective assumes that transaction costs vary in line with the phase of technology life cycle. In the early stage of the life cycle, high market and product uncertainty is expected and the specificity of resources committed to cooperative R&D arrangements is probably high. At later stages, when a technology seems to have fully developed, little uncertainty may

[8] For more on how technologies evolve through various stage and the attributes of each stage, please refer to Fleisher & Babette (2003).

remain, but highly specific investments may be less necessary. Thus transaction costs could be expected to arise more often at the beginning than at the end of the technology life cycle (Brockhoff 1992). Indeed, in the early stage of the technology life cycle, it is usually hard to define what knowledge is required to develop the technology and to identify its coverage area, making it difficult to draw up a precise contract on what to do and how to do. In-house development is thus ideal in the early stage of the technology life cycle.

On the other hand, in the maturity phase of the technology life cycle, the strategic priority shifts to reflect strong pressure on profit margins, the importance of complementary knowledge assets, and pursuit of a growth strategy through aggressive capacity-building (Cainarca, et al. 1992). As customer demands and the focus of competition with other firms becomes clearer, so does the boundary of technological innovation activities. Under these conditions, a cooperative relationship may help a firm pursue its strategic priorities more cheaply and efficiently. Therefore, the TC perspective suggests that firms should opt for technology cooperation when a particular technology project is earmarked for development at the later stages of the technology life cycle. In other words, the TC perspective advises that cooperative method will be helpful as competitive pressure increases and the technology becomes better defined.

The RB perspective refutes the TC perspective's assertion. Technology alliance can help ensure first-mover advantage and establish the firm's product as a dominant design when a specific technology is earmarked for development in the early stage of the technology life cycle (Teece 1986). For instance, basic research (taking this to mean an R&D activity aimed at developing fountainhead technology) tends to focus on the distinctive capabilities of a firm. This is certainly the most costly research, requiring a lengthy time-span to make a return on the initial investment. Carrying out such basic research in-house is infeasible for many cash-strapped HTSFs. Empirical study indicates that firms perceive benefits in cooperation during the early stage of the technology life cycle for industry-wide technological development (Tyler & Steensma 1995).

During the mature stage, when the knowledge resources necessary to the technology project are well-codified, explicit and protected by patent, the new technology project is much less firm-specific and idiosyncratic. At this point, the project functions more or less independently of the firms' idiosyncratic routines and the firms can obtain relevant project-related information from various sources; they do not necessarily have to rely on strategic alliance. Even if the project is carried out through close cooperation with other firms, the value created together will not be as great as the both partners expect. Value creation is greatest when both partners invest and pool firm-specific and uncodifiable knowledge, through which they create further unique and inimitable strategic resources. Since this advantage is less in the project targeting technology located mature phase, internalisation acquisitions or spot market exchange may be preferred, helping the firm to promptly access the existing technology.

As the TC perspective predicts, developing technology at the early stage of its life cycle entails several risks for Korean HTSFs, mostly associated with transaction costs. Externalising such transactions certainly involves the problem of incomplete contracts. On the other hand, Korean HTSFs may prefer external sourcing methods for projects targeting technology at the early stage of the life cycle, i.e. fountainhead technology. Fountainhead technology is the primary source of economic rent allowing the innovator to enjoy long-run profits, such as Qualcum's CDMA technology. Given the high costs involved and long time needed to realise such technology, cooperation is the only option for HTSFs. To examine two contrasting perspectives between TC and RB, this study hypothesises that:

H1-7: Ceteris paribus, as the perceived phase of technology life cycle reaches the mature stage, the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project.

Or

H1-7: Ceteris paribus, as the perceived phase of technology life cycle reaches the mature stage, the decision-makes of Korean high-tech small firms will choose technology alliance for new technology development project

Perceived level of the technology uncertainty

Technology uncertainty is endogenous uncertainty that can be decreased by a firm's actions (Folta 1998). It may, for example, be caused by an inability to assess the key specifications of the technology earmarked for development, or an inability to define the key components of the technology that enable the product to perform at the level in its specification; it may arise because the technology's performance potential is not fully proven and the firm is unable to grasp what the customers expect from the technology.

Technology uncertainty is assumed to be correlated to the life cycle phase of technology; for instance, earlier stages may feature greater technology uncertainty than later stages. This study, however, takes technology uncertainty to be an independent factor. This is because the relationship between technology uncertainty and life cycle phase is not always linear, as innovation and improvement can be introduced at any stage depending on how to define it (Narula 2001). Despite technology uncertainty, HTSFs cannot defer commitment to new technology development until technology has been fully proven and verified: by then, they may have lost the chance to commercialise new technologies ahead of competitors and thereby failed to differentiate their products. These kinds of uncertainty are only resolved by actually undertaking the project. Projects involving a greater degree of endogenous uncertainty involve a wide range of potential outcomes and more growth potential (Folta 1998). Technology strategy must be carefully selected if a project involves endogenous uncertainty.

The technology uncertainty in this study is based on Huber, et al.'s (1975) study proposing two dimensions of technology uncertainty. The first dimension is technical uncertainty, which revolves around whether the technology will work as it is intended to throughout the project. By its nature, newly developed technology is always uncertain with regard to its design and function regardless of how technologically capable a firm is (Nelson & Winter 1982). Whether the newly-developed technology works or not cannot be determined until the development is actually done. HTSFs' substantial investment in time and money may prove to have been all for nothing if the technology development does not provide a workable technological solution. The second dimension is commercial uncertainty, which is related to technical uncertainty. When the new technology developed fails to satisfy customers' expectations, its commercial success cannot be guaranteed. In this case, small firms risk locking themselves into a technology that is neither commercially accepted nor profitable (Liberman & Montgomery 1988). Because of technical and commercial uncertainty, many 'great opportunities' perceived by entrepreneurs ultimately prove disappointing.

The TC perspective argues that technology uncertainty is a source of inefficiency in market contracts, in this case, external sourcing (Schilling & Steensma 2002; Pisano 1990). High technology uncertainty makes it difficult to write, execute and monitor contractual arrangements (Teece 1986). In addition, the likelihood that technical know-how will lead to an innovation with market potential is also uncertain. Other developing technology may prove to be more effective, rendering the chosen technology project less valuable. Because the future of technology is uncertain, establishing a complete contract covering all possible contingencies is problematic, leading to a series of renegotiations and contingency clauses to cope with likely disputes (Pisano 1990). Such renegotiations increase the chances that the collaborating parties will indulge in self-serving behaviour and opportunism, creating excess transaction costs. Thus, in-house development may be preferable to external sourcing under these conditions because the incentive structure of the former is more efficient than the latter.

In contrast, the MP perspective suggests that the inherent uncertainty of new technology development mitigates each partner's desire for self-serving behaviour and opportunism, exerting pressure on the firm to externalise development with its associated risks (Steensma & Fairbank 1999). The greater the technology uncertainty associated with a technology development project, the greater the HTSFs' need for an organisational structure that allows it to hedge its bets on the project and increase its chances of survival. Strategic alliance, particularly non-equity alliance such as licensing, is a viable option. When technology development involves substantial technical uncertainty, external sourcing is advantageous in that there are no sunken development costs or long-term expenditure that the firm must attempt to recoup. If the expected value of the completed project falls due to sudden technological breakthroughs, firms using external sourcing can temporarily or permanently discontinue investment in the project without being financially ruined (Porter 1983).

In summary, the technology-sourcing method pursued by HTSFs can be influenced by technology uncertainty and the sourcing mode's ability to dissipate the risks involved. As the contrasting predictions of both TC and MP perspectives make clear, however, there is no agreement on the best sourcing mode given high levels of technology uncertainty. To examine contrasting perspectives, the present study hypothesises that:

H1-8: Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project
Or
H1-8: Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development project

! Perceived environmental factors and technology-sourcing decisions

As suggested in the previously chapter (in the review of resource dependence (RD) perspective and market power (MP) perspective), a firm must adapt to its environment if it is to remain viable. By focusing on the industry environment in which a firm has relationship with customers, suppliers and competitors, the firm may be able to analyse what macro-level profit determinants and how the firm should alter its relationship with them to maximise the profit. Based on this idea, this study argues that, for the project to make the long-term profit, the decision-makers should understand not only the current condition of the their firms, but also anticipated change of their market in the future. Therefore, technology-sourcing decision should be carefully designed and chosen to minimise the shock resulted from the unexpected environmental change, thus, make the project successful. Unfortunately, what sorts of environmental conditions that the decision-makers of HTSFs are likely to screen before technology-sourcing decision have not been clearly pinned down.

The environmental condition of a firm may be thought of as the totality of physical and social factors that are taken directly into consideration in the decision-making behaviour of individuals in the organisation (Duncan 1971). Environmental conditions may include internal aspects of the firm such as interpersonal behaviour style, the interdependence of organisational units or the process of integrating individuals in order to obtain the firm's goals internal environmental condition. This study, however, conceptualises environmental conditions from the organisation outward. Specifically, the external environmental conditions of firm centre on how decision makers perceive the volatility (unpredictability) of the firm's complex external environment in terms of suppliers, customers, technological shift, market growth rate, variation of competitors' technology sourcing strategy and regulatory agencies (Miles & Snow 1978).

Having environmental condition as a determinant, the TC, RB, MP and institutional perspectives recommend contrasting view on how it implies to the technology-sourcing decision. To test their validity, this study proposes that three observable factors are heavily influencing the volatility of the firm's complex external environment. These are perceived environmental uncertainty, perceived market growth and legitimacy for alliance (pressure for cooperative strategy). This study argues that the extent to which the decision makers of Korean HTSFs perceive them to vary will affect their technology sourcing method. This is developed in the next section.

Perceived level of the environmental uncertainty

The external environment of a firm is rarely stable and predictable. Firms thus always face difficulties in deciding how best to adapt to it. According to Duncan (1971), environmental uncertainty is caused by three factors:

(a) The lack of information regarding environmental factors associated with a given decision

(b) Not knowing the outcome of a specific decision, i.e. how much the organisation would lose if the decision proved incorrect

(c) Inability to assign probabilities with any degree of confidence regarding how environmental factors will affect the success or failure of the decision in performing its function

Perceived environmental uncertainty is the decision maker's inability to predict how component of the environment (such as socio-cultural trends, legislation, demographic shifts and major new development of technology) might be changing. This uncertainty is an exogenous uncertainty, rooted in the overall technological environment, which is unaffected by a firm's action. When these components are changing unexpectedly, the HTSFs' efforts for new generation of technology may render obsolete (Folta 1998). Mostly, it will be difficult to discern what kinds of capabilities are critical to whether the unpredictable environment varying widely.

A number of studies show that perceived environmental uncertainty exerts a considerable influence on organisational structures and process. But, findings from the effect of environmental uncertainty on governance decision appear to contradict one another. For instance, supply uncertainty pushes firms to integrate vertically whereas demand uncertainty makes vertical integration risky, owing to obsolescence or seasonality (Jones, et al. 1997). Walker and Weber (1984) provide empirical support that vertical integration is efficient response to the environmental uncertainty. In contrast, Harrigan (1985) suggests that environmental uncertainty results in lower rather than an increased degree of vertical integration. The reason of the divergent empirical findings is that environmental uncertainty hinges on numerous dimensions and different source of dimensions have different implications. This study suggests following dimensions of perceived environmental uncertainty should be considered before making technology-sourcing decision.

The first is the uncertainty of the competitor's action (Sutcliffe & Zaheer 1998; Porter 1980). In response to the new technology project, the competitors may initiate price-war with their competing products or announce similar types of technology project. Whether the competitors' retaliate action is based on their deliberate or innocent strategic motivation, the incumbent firms have to pay the price for series of competitive reaction at the risk of losing profit margin and market share. In addition, potential new entrants may emerge taking advantage of imitating or advancing the result of the technology project.

The second is the unpredictable demand as well. Certainly, the demand must be sufficient to justify the firm's investment in technology project. Uncertain demand is generated by rapid shifts in consumer preferences, by rapid changes in knowledge or technology resulting in short product life cycles, by rapid dissemination of information critical and by seasonal fluctuation (Jones, et al. 1997). Predicting potential demand precisely including potential price that customers are willing to pay and the size of estimated market is getting difficult due to unpredictable technology trajectory. New products are being introduced at a faster rate and technology fusion is occurring across and within industries, thus, new product and technology obsolescence is becoming rampant (Song & Motoya-Weiss 2001). Therefore, no matter how ambitious and well-understood the decision makers are about the new technology development project and its application, their perception of uncertain technological environment casts prudent consideration on how to carry out and manage the project. The decision-makers' perception becomes the reality: they opt for less risky methods that help avoid uncertainty to carry out the project.

TC perspective sticks to its original tenet. Under high level of perceived environmental uncertainty, in-house development is preferable. For instance, higher demand and competitive uncertainty complicates alliance contracts, creating a greater number of contingencies that have to be dealt with *ex post*. That is, the transaction costs arising from specifying, monitoring and enforcing a workable contract for a technology development project are higher when environmental uncertainty is highly volatile (Robertson & Gatignon 1997). In addition, the firm has to incur protection costs to prevent the knowledge leakage to the third party by the partner under the highly uncertain competitive market (Kotorov 2001). This include costs of protecting and controlling the use and dissemination of valuable information such as technology patents. Once these reveal to the third party, the firm may production loss and asset obsolescence due to competition. Consequently, as perceived environmental uncertainty increases, the efficiency of technology-sourcing decreases. Thus, internalisation emerges as favourable transaction-efficient governance structure.

Contrarily, MP perspective view that in-house development is ill-suited for ensuring the profitability of the technology project under the environmental uncertainty. As seen in the previous chapter, MP perspective emphasises the defensive and strategic role of the technological collaboration. The global technological environment has been characterised by penetration of small and large firms everywhere and fickle customers demand ever. These uncertain environments may damage the small scaled- but focused technological innovation effort of HTSFs by sudden market shrink or shift. Committing prematurely the project alone may impose the tremendous risk upon such shock. Therefore, the HTSFs should hedge their bets (projects) against such mishap. Harrigan (1988) and Jones, et al. (1997) content that technology cooperation will be able to increase the firm's flexibility to respond to a wide range of unexpected environmental contingencies by reallocating the firm's resource bundles cheaply and quickly through exchanging with other firms. Without the defence capability to the firm's know-how developed from the innovation effort, the keen followers or new entrants may appropriate the profit of the original innovator (Teece 1986). Technology cooperation is the leading and effective mechanism for lowering the costs of strategic defence and entry-deterring investment by combined market power with the partner (Kogut 1988).

Similar to MP perspective, the RB perspective argues that firms with higher order resources and competence can carry out internal new technology development better than competitors (Barney 1991; Wernerfelt 1984). However, the firm's resource advantage may be neutralised or dissipated if it fails to modify its resources in response to changes in the technological environment (Peteref 1993; Barney 1991). As a result, a capability or resource that was once a strategic asset becomes a liability if it is no longer appropriate in a new technology environment. The firm's core capability and resource can become its core rigidity as its environment changes. Thus, when perceived environmental uncertainty is high due to uncertain technological trajectory, there is less incentive to carry out the project internally, and the firm would be better off waiting or seeking collaboration with other firms.

Considering TC and MP/RB perspective together, the impact of perceived environmental uncertainty on the technology sourcing decision is inconclusive. On the one hand, Korean HTSFs cannot give up or delay the irreversible investment expenditure for the project due to potential exogenous uncertainty (environmental uncertainty) that the firm can do little about it, thus, technological cooperation emerges as an option. On the other hand, however, forming technological cooperation could create further uncertainty. For instance, high-tech small firms engaged in alliance would have difficulty agreeing on a contingent scenario on which to base R&D cooperation. Significant costs also arise when transactions are maladapted due to unexpected environmental shocks. This study will test two divergent predictions among TC and MP/RB perspective. Therefore, the hypotheses will be:

H1-9: Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the decision-makes of Korean high-

tech small firm will choose in-house development for new technology development project
Or
H1-9: Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the decision-makers of high-tech small firms will choose technology alliance for new technology project

Perceived level of the market growth

If the prediction of resource dependence (RD) perspective is correct as seen in previous chapter, HTSFs will be less likely to rely less on other firms in the fast growing market because they can achieve relevant resources from resource munificent environment (fast growing environment) via various sources, not limited to the key potential resource providers. As stated in Chapter 3 (pp.44), the key characteristic of Korean telecommunications industry is its speedy growth during the past 5 years along with rapid domestic telecom-market expands. The growth triggers growing number of highly qualified employees (engineers, scientists and Ph.Ds) and trainees motivated by career objective and higher salary standard. These phenomena reflect the fact that faster market growth induces munificent knowledge- and human-resources which are, in fact, the most essential element in technology-intensive industry. The key requirement of the technology project is to have the qualified technician within the project team to interact, generate, exchange, store and internalise valuable knowledge. In this respect, Korean labour market for qualified human resource is much less stifled than in the previous periods.

As the domestic market grows ever and employment market becomes deregulated and flexible, their mobility rate within the intra- and inter-industry becomes faster than in any other sector. Qualified and mobile employees accumulate various real-life tasks and experiential knowledge, at the same time, informal network through their experiences. Affluent qualified human resources and their mobility allow Korean HTSFs easier access to the informational resources by hiring them. For instance, feedback can be considered significant informational resource valuable to the technology project. Feedback provides information useful in correcting errors and new ideas inflow during the project toward meeting the original goal (Ashford &

Cummings 1985). Technology alliance such as licensing and R&D contract has been the major tool for HTSFs to receive feedback- to resolve the ambiguity and discomfort in the project. Hiring individuals possessing a sense of mastery or relevant external social network to ask for feedback helps the Korean HTSFs reduce the reliance on other firms for doing the same objective. As hiring these people become much more relaxed, Korean HTSFs are getting less dependent on other firms thorough technological cooperation, particularly on the large corporation.

Unlike RD perspective viewing the impact of market growth in terms of resource availability on the technology-sourcing decision, the MP perspective see its impact in terms of its opportunity side, maintaining that exploiting market opportunities is the key driver of alliance formation. Alliance formation will grow in a growing market rather than in a declining market simply because more business opportunities are likely to be available in the former (Harrigan 1988). In a growing market, various product and technology niche markets that large firms bypass and in which economies of scale are not critical will emerge; the small firms can exploit and fill this market segments (Gomes-Casseres 1997). Thus, more firms enter the market to pre-empt new niche markets and achieve market predictability. Under such conditions, alliance can offer participating firms additional economic rent through increased market power, sales, economies of scale and scope, shared production at lower costs and speedier innovation. In a declining market, such potential benefits would be offset by uncertainty over the future of the firm and the market itself. In addition, acquiring financial resources through alliance is far from straightforward due to the unclear market prospects in a declining market, thus making initiation or maintenance of alliance more difficult. As a result, the number of alliances will increase in growing markets, as firms become more concerned with pre-empting the market and outdoing their competitors in technological innovation.

To examine two contrasting perspectives, this study hypothesises that;

H1-10: Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose in-house development for the new technology development project
Or
H1-10: Ceteris paribus, the greater the perceived level of the market growth, the

greater the likelihood that the decision-makes of Korean high-tech small firms will choose technology alliance for new technology development project

Perceived level of the legitimacy of the alliance (pressure pushing firms to pursue a cooperative strategy)

The industry's institutional environment is a key external factor influencing a firm's technology-sourcing decisions. In previous chapter, the institutional perspective explained that, under increasing uncertainty and ambiguity in the environment, the behaviour of other firms within the system may provide a reference to the incumbent firm; organisational leaders will be motivated to monitor the actions of other organisations in their field to find viable solutions to organisational problems (Beamish & Killing 1997). For instance, decision-makers will rely on direct or indirect communications linkage to gather information that can be used to evaluate strategic decisions. Similarly, decision makers will take into account what other firms in the same field are tending to do (DiMaggio & Powell 1983). This assumes that decision-makers will perceive any action practiced frequently by a large number of firms as an effective and taken-for-granted practice, and will adopt it without further rational evaluation. As a result, the system-wide practices and rules embedded in popular management practice are easily diffused and accepted as norms of reciprocity as other members imitate them. This phenomenon can be seen in training, rotation of managerial personnel, hiring employees and corporate strategy (DiMaggio & Powell 1983).

A similar logic can be applied to a firm's technology-sourcing decisions. The institutional perspective argues that technology cooperation becomes a currently accepted (or rationalised) activity: in fact, a growing number of high-tech global firms have been engaged in breakthrough projects based on technological cooperation and, at the same time, academics have emphasised and rationalised such technology cooperation (see Rumelt, Schendel & Teece 1994). Small firms try to mimic the cooperative actions of these global firms because the latter's behaviour is seen as legitimate and prevailing norms in the high-tech industry. Therefore, strategic alliance will continue to proliferate due to mimetic isomorphic pressure in the industrial environment. This argument stands in stark contrast to the TC perspective, which predicts that alliance will be a short-lived or temporary phenomenon due to its inherent limitations (opportunistic behaviour of partners pursuing their own interests).

Although the argument of institutional perspectives lacks strong empirical supports, the institutional perspective casts useful light on understanding Korean HTSFs' technology-sourcing behaviours. Dacin, et al. (1997) puts that Koreans' standard of success and failure are more closely associated with approval and disapproval of significant others than with inner personal standards or goals. Although Korean HTSFs approach strategic decision-making as a function of variance in their strategic orientation, how others as a whole will perceive their action as legitimate will be influential to their decision. Thus, they will scan the practice of significant others (large global firms or industry leaders, in particular) with regard to their issues at hand to estimate the legitimacy of relevant action. Scanning will be conducted through observing direct competitors, information exchange with customers/suppliers, bankers, consultants, general/trade publications, trade show and others.

In South Korea, strategic technology alliance is perceived as a routine industry-wide and has been established as a rule-like tactic in organisational strategy setting. The telecommunications industry is no exception. The financial crisis that hit South Korea in the late 1990s is partly responsible for this phenomenon. Many HTSFs suffered from severe financial shortages and deficits. Limited funding from public institutions weakened their technological innovation efforts and business closure. Working with other firms helped firms smooth stringent cash-flow and escape acquisition by larger companies. In fact, a firm's announcement of technological partnership symbolised its capability at a difficult time. It enhances reputation, organisational image and technological prestige, attracting attention from resource-granting agencies, foreign investors or external stakeholders. Therefore, technological partnership, especially with a prestigious firm, became legitimate and other firms rushed to reach similar agreements. When decision-makers perceive technology cooperation as legitimate, they are likely to go for it. This study thus proposes the following hypothesis:

H1-11: Ceteris paribus, the greater the perceived level of legitimacy of the alliance (pressure pushing firm to pursue cooperative strategy), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose *technology alliance for new technology development project.*

! Controlling factors and technology-sourcing decisions

So far, essential determinants of technology-sourcing decision in terms of observable factors have been identified and their predicted influence has been reviewed. Following three factors are not the focus of this study, but they may still have an impact to the technology-sourcing decision.

Perceived level of the government support

Lastly, central and regional government support for collaboration, including formation of research associations and consortia, relaxation of legislative restrictions and creation of large numbers of technology transfer organisations, can be viewed as an environmental factor impacting the technology-sourcing decisions of HTSFs. Many developed countries have adopted such policies. European programmes such as ESPIRIT, EUREKA and ALVEY are the examples.

Since the mid 1990s, the Korean government has introduced several policies to promote technological cooperation between industry, institutes and universities, such as the Promotional Act on Small Firms Technological Cooperation of 1993. This includes helping supply cooperating firms with knowledge resources, R&D workforce training and mediation/arbitration with foreign partners. Tax incentives promoted interfirm collaboration. Since 1997, the Ministry of Commerce, Industry and Energy (MCIE) has initiated a consortium for technological cooperation, combining 19 major universities and 11 research institutes to transfer gratuitous conveyance of technology to small and medium electronic manufacturers. The industrial Technology Association, a non-profit organisation, was established in 1995 under the Act of Promotion of Industrial Technology Association to develop fundamental technology; it mostly assists small and medium sized firms. Presently, 81 sub-associations are attempting to enhance government technology policy by evaluating the cooperative approaches of industry/academies/research institutes.

Dodgson(1993) argues that if the government support system for technological cooperation is well organised, firms prefer technology cooperation (i.e. R&D cooperation), and if poorly organised, firms prefer technology purchasing. It can be argued that government support for specific modes of acquiring needed technology increases firms' proclivity to adopt such modes. The Korean government realised that the combination of small firms serving a small and protected national market and closed economic systems that discouraged the exchange of ideas and personnel among firms, institutions, universities and research institutes, and had stymied the technological capabilities of the dominant Korean HTSFs. An active venture capital market and government support for technology development projects, together with exchange among industry players was needed to promote technological innovation among HTSFs. It is impossible to investigate the full impact of government efforts on the technological cooperation activities of HTSFs in this chapter. However, it is likely that as the decision-makers of Korean HTSFs perceive the incentives and benefits offered by policies promoting technology alliance, they will be more likely to opt for such alliance, all other things being equal. Thus, the present study proposes that the various technology cooperation promotional acts have led Korean HTSFs to pursue technology cooperation for new technology development.

H2: Ceteris paribus, the greater the perceived level of governmental support for technology cooperation, *the greater the likelihood that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development*

Perceived level of the financial costs of development

Development costs are always a critical factor for small firms in reaching technology-sourcing decisions. New technologies are extremely expensive to develop. For instance, a new microprocessor can cost about 120 million pounds to develop. A new telephone switch generation can cost over 600 thousand pounds. These high costs imply that small firms simply cannot afford to carry out such projects even they have a good knowledge basis for them. Collaboration can help HTSFs share these high costs, although returns will be shared. Collaboration can also reduce the unnecessary duplication of R&D efforts. Previous studies argue that firms will go for in-house technology development in medium-cost technology development projects, while they will prefer technology purchasing in low-cost projects(Dodgson 1993, 1992; Hamel 1989). Developing new technology can represent a disproportionately large financial risk. Many HTSFs also experience great difficulty attracting enough funds to capitalise on their innovative capabilities. Technology alliance thus emerges as an alternative means to pursue a technology development project at lower cost and risk.

This study proposes that the estimated cost of the new technology development project is the key factor leading many Korean HTSFs to opt for technology cooperation. Carrying out costly R&D projects through alliance reduces investment recovery periods in the global environment, which can be a competitive advantage in the high-tech industry. Technological cooperation thus offers significant financial benefits to HTSFs pursuing technological innovation. Therefore, this suggests following hypothesis:

H3: Ceteris paribus, the greater the perceived level of developing costs of carrying out the project, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development

Firm size

Although firm size is the most widely considered factor in the literature as a factor affecting the technology-sourcing decision, its influence is contradicted. For instance, Hagedoorn and Schakenraad (1994) find a positive relationship between firm size and its tendency to the cooperation while Pisano (1990) and Robertson and Gatignon (1998) do not encounter such relationship. Intuitively, firms with sufficient financial, technical human resources are capable of undertaking R&D activities either internally or externally while small firms with limited such resources require cooperation with others to handle research project. In this study, firm size in term of sales size is used as a controlling variable to find its impact on the technology sourcing decision of Korean HTSFs.

5.2 Hypotheses in the second phase of decision-making (stage two)

For firms choosing in-house development method, no further decision-making process is needed except that they proceed it. However, firms opting for external sourcing method must proceed to the second phase of the decision making process: how to structure it. Applying the same basic logic in the first phase of decision-making (in-house development vs. external sourcing), the decision-makers consider several economic, environmental, strategic and organisational behavioural aspects to establish appropriate structure of external sourcing, largely between equity and non-equity technology alliance. The specific consideration criteria will vary across HTSFs depending on their own preference and logic. Among many, this study argues that the unique consideration criteria in stage two, different from the stage one, is the fact the decision-makers should consider potential hazards by the potential partner that may occur throughout the relationship.

This study argues that the decision-makers should concern two hazards (external shocks) before making technology cooperation method: shirking and misappropriation of intellectual property. Shirking occurs when one or more partners deliberately contributes less or lower quality input to joint activities than originally agreed, while misappropriation is related to uncompensated transfer of technological know-how between partners. Equity and non-equity alliances have different capacities to deal with such hazards. The following table is a simplified 2X2 table shows the relationship between hazard condition and alliance governance structure.

(Table 33) The relation between alliance governance mode and contract hazards

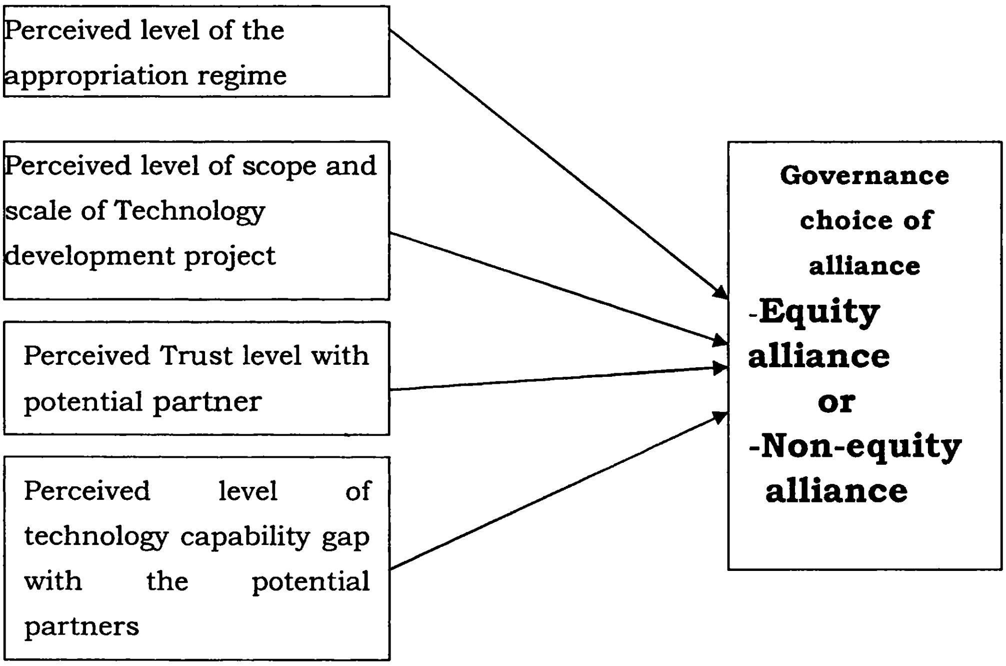
		Alliance governance mode	
		Non-equity alliance	**Equity alliance**
Contract Hazards	**Low**	***Appropriate***	Excessive bureaucracy
	High	Inadequate control	***Appropriate***

(Adapted from Sampson 1999)

The contract hazards are contingent on the institutional environment in which the cooperative relationship is formed and its transaction is characterised. Identifying components of potential contract hazards and their measurements are numerous. This study argues that structuring technology cooperation is influenced by the decision-maker's perceived level of the contract hazards, and this can be indirectly measured by the decision-maker's perception on the appropriation regime of new technology, scope and scale of the technology project, the trust level with the potential partner and the technological capability gap with the potential partner. Figure 6 summarise their relationships.

(Figure 6) Determinants of decision making in the second stage

Framework



Based on this framework, following hypotheses are generated which will be discussed in the next section.

	Hypotheses	Prediction based on theoretical assumptions
H1-12	**(Perceived level of appropriation regime)** Ceteris paribus, the weaker the perceived level of the intellectual property regime (appropriation regime), the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose equity alliance**	TC, RD
H1-13	**(Perceived scope of technology development project)** Ceteris paribus, the broader the perceived scope of cooperative activity (not only including R&D activities but	TC, RB

	also manufacturing, marketing and/or supply activities as well), the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose an equity alliance** for new technology development project	
H1-14	**(Perceived scale of technology development project)** Ceteris paribus, the broader the perceived scale of cooperative activity (not only limited one technology but also covering range of products/technologies), the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose an equity alliance** for new technology development project	TC, RB
H1-15	**(Perceived trust level with the potential partners)** Ceteris paribus, the stronger the perceived trust level with the potential partner, the greater the likelihood that the decision-makes of Korean high-tech small firms **will choose non-equity alliance** for new technology development project	SN
H1-16	**(Perceived level of the technological capability gap with the potential partner)** Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose an non-equity alliance** for new technology development project.	SN, RB
	Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose an equity alliance** for new technology development project.	MP

(TC: transaction cost perspective; RB: resource based perspective; SN: social network perspective; MP: market power perspective)

The next sections investigate theoretical rationale on which these hypotheses are built.

!Perceived level of appropriation regime and structuring technology alliance

Knowledge sharing is the key to success in an alliance. The higher the level of interaction and cooperation, the greater the benefits of joint development. However, this means that HTSFs have to reveal critical knowledge and skills to their alliance partner, which can lead to appropriation or imitation by the partner without paying the price. In this sense, strategic alliance forces HTSFs to deal with the 'boundary paradox'; the firm should be open to knowledge flowing in from external sources, yet at the same time protect its firm-specific knowledge (Norman 2002). Firm-specific technological know-how is the competitive edge of a high-tech firm. If this is leaked and transferred unintentionally or deliberately to the alliance partner during the normal course of the interfirm relationship, the firm's own technological competitive advantage and attractiveness will diminish not only as an alliance partner but also as a firm *per se.* HTSFs thus need to consider how to balance knowledge protection and knowledge sharing prior to structuring technology cooperation.

According to Teece (1986), appropriability or a 'regime of appropriability' refers to a firm's ability to seize returns from its innovations. This refers to another type of concern about appropriation in technology cooperation: a firm's concern about its ability to capture a fair share of rents from the alliance in which it is engaged (Gulati & Singh 1998). In theory, a patent or intellectual property right confers considerable protection and perfect appropriability on a new product developed by the innovator. This is however rarely the case in reality; patents are invested around at modest cost and they are especially ineffective at protecting tacit knowledge such as process innovation, applications-level know-how and R&D capabilities (Teece 1986).

Tacit knowledge cannot be completely or easily articulated and codified within the patent or intellectual property right. If tacit knowledge involves a high level of causal ambiguity, competitors have trouble imitating the firm's skills and capabilities when observing from a distance (Zander & Kogut 1995). However, when firms enter into a close working relationship with intimate personal contract, teaching, demonstration and participation (i.e. a strategic alliance), tacit knowledge is more readily observed, transmitted and internalised by the partner (Dodgson 1993). Thus, restrictions, ownership and property rights should be incorporated into the alliance agreement to prevent unobserved violation by the partner firm such as modifying knowledge without permission or transferral to third parties (Pisano 1990). However, it is difficult to clearly specify them in the written agreement when they are, for instance, related to high level of tacit knowledge, that is because it is difficult to assess what is exchanged without the complete information from the partner (Gulati & Singh 1998). The impossibility of full monitoring further aggravates concerns about appropriation of rent resulting from technology cooperation.

On the other hand, industries differ significantly in their propensity to patent industrial innovation as well as in how rapidly new technological information leaks out to rivals. If an industry features a tight appropriability regime, firms can retain the rent earned from their proprietary resources, while in a loose regime, these rents tend to leak out or spill over to other firms (Teece 1986). For instance, the chemical and pharmaceuticals industries are known for their strong appropriability regime, while the telecommunications industry is not.

The TC and RD perspectives are highly concerned at appropriability issue in interfirm relationships, suggesting that hierarchical controls are an effective response to high levels of appropriation hazard at the time the technology alliance is formed (Oxley 1997; Williamson 1985). The logic underpinning hierarchical control as a response to appropriation concerns is that such controls can impose control by fiat, providing monitoring, aligning incentives and managing misappropriation. For instance, equity stakes in a joint venture provide a mechanism for distributing residuals when *ex ante* contractual agreements cannot be written to specify or enforce a division of returns (Oxley 1997). Creating a mutual hostage situation in the form of shared equity helps to align the interests of all partners because each has an interest in the value of its equity holdings. In addition, in separate administrative hierarchy, managers from two parent companies owning a portion of their equity oversee day-to-day functioning and monitoring, and provide an independent command structure and incentive system. Partners in joint ventures are thus highly likely to limit the use of the other partner's technology to those purposes prescribed in the agreement (Oxley 1997). Furthermore, the on-going relationship embodied in the joint venture reduces the incentive for the technology recipient to sell information regarding the technology to un-related third parties for a one-shot pay-off.

This study proposes that, all other things being equal, Korean HTSFs will choose equity alliance when they perceive that the intellectual property regime (appropriation regime) within the technology cooperation activity is weaker. In Korea, the system of legal protection of knowledge assets tends to be loosely structure, making many small firms wary about forming close relationships with others (see Chapter 3, pp.71). Given a loose legal regime governing knowledge protection, equity-based alliance is much more efficient for minimising knowledge leakage. So, this study proposes that:

H1-12: Ceteris paribus, the weaker the perceived level of the intellectual property regime (appropriation regime), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose equity alliance

!Perceived scope and scale of the technology development project and structuring technology alliance

As TC perspective mentioned previously, how to specify input- or capability supplied by partner firms, and monitor and enforce the terms of the alliance are the key issues in deciding the governance structure of a strategic alliance. Specifying such items technology alliance project is usually more difficult than in other types of strategic alliance such as production agreements or marketing cooperation. This is because the process of technological innovation is not clear-cut, so that fully anticipating input, capability and outcomes is almost impossible when the alliance agreement is written (Oxley 1997). Even for existing technology, adequate specification of each partner's contribution is not necessarily straightforward. Bearing this in mind, we can assume that the degree of specification of input, output and compensation underlies the partners' potential for shirking and opportunistic behaviour, and thus influences governance choice for technology cooperation.

The degree of specification depends on the types of activity involved in technology alliance. For example, technology alliances are rarely designed exclusively for research and development; many involve not only joint R&D, but also manufacturing, marketing and/or supply activities as well. As the number of different activities taking place within an alliance increases, definition and specification of input, capability and outcomes becomes more complicated (Oxley 1997). Overseeing the behaviour of the partnering firms becomes harder as alliance activities become more varied. Alliances covering a broader range of activities beyond R&D present greater appropriability hazards, pushing HTSFs to adopt a more hierarchical alliance governance structure.

Even if the technology cooperation is limited only to research and development, the degree of contract specification depends on the degree of complexity of the technology or product that the firm intends to develop. For instance, the specification of the contract will vary depending on the extent to which the technology alliance involves development of a new product or processes based on either existing technology or unrelated technology included in the contract (Sampson 1999). Input and output are more difficult to specify in advance when the number of products or technologies included in the contract is increasing (Oxley 1997). The greater the number of technologies and products are involved in the project, the greater the difficulty of monitoring the cooperative activities. Where increased scale is necessary, a more hierarchical and closer governance structure is required to observe whether each partner is adequately undertaking the activities prescribed in the technology alliance agreement.

This study therefore proposes that Korean HTSFs, all other things being equal, will choose equity alliance when they perceive that the scope and scale of cooperative activities are broader. The scope of technology alliance is broader when it includes not only R&D activities but also marketing and supplying activities. The scale of technology alliance is broader when it is not limited to developing one technology. Technology alliances broad in scope and scale may create a lot of unexpected contingencies caused by failure to stick to the activities prescribed in the contract, and Korean HTSFs lacking experience of large scale alliance will rely on hierarchical modes of cooperation to mitigate such difficulties. Two hypotheses are suggested here:

H1-13: Ceteris paribus, the broader the perceived scope of cooperative activity (not only including R&D activities but also manufacturing, marketing and/or supply activities as well), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project

And

H1-14: Ceteris paribus, the broader the perceived scale of cooperative activity (not only limited one technology but also covering range of products/technologies), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project

!Perceived trust level with potential partners and structuring technology alliance

Parkhe (1998) argued that interfirm trust plays the most important role in successful alliance; a lack of trust between partners is a major contributor to alliance failure. Strategic alliances are being formed with increasing frequency but are still a last resort rather than a first choice because of the trust issue. Given that the two main types of uncertainty in alliances are unknown future events and the partner's response to these, if partner-trust will reduce complexity and uncertainty far more effectively than authority or bargaining (Baughn, et al. 1997). According to Myer, et al. (1995, pp.712), "Trust is the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party". This study views trust as a subjective and perceived state of positive expectation about the other in a risky situation (Das & Teng 2001). Trust is a multilevel phenomenon conceptualised with multidimensional constructs. If strategic alliance is the unit of analysis, two dimensions of trust are particularly pertinent: good-will trust and competence trust. Good-will trust refers to mutual expectation of open commitment to each other while competence trust concerns the expectation that a trading partner will perform his role competently with devotion and faithfulness (Ring & Van de Ven 1992).

Contrary to the TC perspective's argument that frequent interaction increases the opportunistic behaviour of economic actors and increases transaction costs between two economic players, SN perspective argues that repeated interaction between economic actors lowers transaction costs through increased mutual knowledge, a willingness to share information and enhanced skills generated by mutual adaptation and synergy (Madhok 1995; Jarillo 1988). That is because initially firms try to find a trustworthy partner via prior ties or information gathering within their existing social network to minimise the likelihood of opportunism (Gulati 1995). In addition, self-interested actors involved in frequent interaction would prevent opportunistic behaviour because they realise that trustworthy behaviour benefits them in the long-run, reducing safeguarding costs and generating value on the basis of complementarities in a sustained relationship (Madhok 1995).

The overwhelming role of trust has been widely recognised (see, Ring & Van de Ven 1992). For instance, partners that trust each other do not require detailed contracts and hierarchical control to monitor each other; these even get in the way of creating good exchange relationships between their business units (Gulati 1995). A higher level of trust results in trusting actions such as less use of formal contracts, less detailed agreements to account for contingencies, fewer actions to safeguard knowledge and monitor partner behaviour and greater communication and information exchange (Norman 2002; Ring & Van de Ven 1992). Under trustful environment, each partner will monitor its own actions. In the absence of trust, structural mechanisms are adopted to induce the partner to act in ways that are not detrimental to the firm. With structural mechanisms in place, the partner either has far less opportunity to act opportunistically, otherwise, faces severe penalties. Thus, it has been suggested that control mechanisms and trust are substitutes for one another (Das & Teng 1998).

The more a HTSFs trusts its partner, the less it will try to control the information that flows to the partner or limit the knowledge to which the partner is exposed. This is because the focal firm believes that even if potentially useful knowledge gets into the hands of the partner, it is less likely to use this knowledge in ways that are detrimental to the focal firm. The SN perspective points out that many firms are increasingly embedded in a social network through which they are connected with one another either directly or indirectly. Within such a dense social network, untrustworthy behaviour by one firm such as cheating and shirking may have reputational consideration which adversely affect the firm's ability to negotiate future relationship with other firms (Gulati 1995). Indeed, untrustworthy behaviour does bad to the firm itself. Of course, it should be noted that trust does not completely eliminate the need for strong ownership and control in inter-firm relationship. However, it certainly reduce such needs greatly if the focal firm sees its partner reliable; the focal firms will rely on the goodwill of the partner rather than restricting and monitoring communications with it and limiting exposure under strict governance rule. Therefore, this study proposes following the hypothesis:

H1-15: Ceteris paribus, the stronger the perceived trust level with the potential partner, the greater the likelihood that the decision-makes of Korean high-tech small firms will choose non-equity alliance for new technology development project

! **Perceived level of technological capability gap with the potential**

partner and structuring technology alliance

Technology gap refers to the difference in technological capability between partners, but it has multiple dimensions. The SN perspective sheds light on status similarity, assuming that similar status firms possess similar compatible technological capability and operating and administrative systems. When there is an asymmetry in the status of potential partners, the high-status firm's interest in technology cooperation stems from the fact that its superior bargaining position enables it to secure favourable contract terms (Stuart 1998). From a lower status partner's point, a significant value can be created through alliance with a high-status and highly technologically-capable firm, not only as a technologically transferable context but also as a reputation effect.

According to the social network (SN) perspective, the partner's status similarity or dissimilarity influences their alliance governance mode. When higher status firm (the holder of valuable technological resources) enters into alliance with lower status firms, the former can retain a large share of the value created in the partnership. Thus, the need for complicated contracts and commitments such as joint ventures diminishes. On the other hand, firms of similar status are more likely to form joint ventures because of the signalling role of social interaction compatibility in administrative systems and increased level of fairness and commitment in sharing both the costs and benefits of alliance (Chung, et al. 2000). In fact, joint ventures between partners of dissimilar status would be likely to discourage participants from committing the same level of resources: the higher status partner will commit resources of the same calibre as the partner of lower status, while the latter will expect the higher status partner to commit more resources, dissatisfying both. Therefore, when there is status dissimilarity between alliance partners, short-term, less committed and contract based non-equity alliances will prevail.

The RB perspective suggests similar prediction to that of SN perspective. The RB perspective views the partnering firms' technological gap in terms of difference in absorptive capacity and resource complementarity. Considering that learning is the primary objective of technology alliance, technology alliance should thus occur between firms which both have an *ex ante* technology-based capability similar in scale and scope or some level of technological overlap to facilitate knowledge exchange and mutual learning (Mowery, et al. 1998). When two partners possess a roughly equal absorptive capacity, complementary skills and capability, an equity-based joint venture will maximise the learning effect as it is accompanied with tight coupling, richer communication and formalised regular group meetings and a higher level of mutual commitment between partners.

Although the MP perspective stresses the role of technology alliance for improving competitive advantage of a firm, it contrast with SN and RB perspectives when considering the role of technology capability gap on alliance governance decision. It argues that a joint venture with firms possessing a similar technological capability is not recommendable for technology development because the market then becomes more volatile as more competitors learn about the firm's hitherto-unknown approach to serving customer needs through close interaction of joint venture (Harrigan & Newman 1990). A joint venture with similarly capable firms may thus serve as a stepping stone for the establishment of future competitors. However, under non-equity alliance agreements, such risk will be diminished as both partnering firms have a relatively small stake in the success of each other's technological exploits, and are less inclined to expend significant organisational resources on the partnership above and beyond what is specified contractually (Steensma & Corley 2000).

The MP perspective points out the advantage of non-equity alliance in that the extent of communication and interaction between the sourcing and source firm is likely to be limited, but, partnering firms may still exchange knowledge with minimum exposure and enjoy the benefit of technology alliance: to defend the firm's strategic position in the existing market and to exploit the market opportunity. Thus, technologically similar firms are not recommended to form equity-alliance each other while it would be better off for doing so between technologically dissimilar firms. Conversely, technologically dissimilar firms requires to force the use of safe organisational form (quasi-hierarchical arrangement) such as equity alliance when structuring effective cooperation mode. Although its governance costs might go up due to difficulty of its management, this arrangement is more adaptive for co-aligning technologically dissimilar firms.

Considering two different views together (SN/RB vs. MP perspective), this study will examine what will be the appropriate recommendation to the

Korean high-tech small firms. Thus the hypotheses will be:

H1-16; Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an non-equity alliance for new technology development project.

Or

H1-16; Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project.

Conclusion

In this chapter, a two-stage contingency model of technology-sourcing decisions has been proposed. The model assumes that Korean HTSFs go through two sequential and contiguous steps to structure their new technology/product development projects. In the first phase of decision-making, they choose between in-house development and external sourcing methods, i.e. strategic alliance. Based on the relevant literature, three aspects, each comprising eleven components altogether, were selected and reviewed. For firms choosing external sourcing methods, the second phase of the decision making process is about how to structure the strategic alliance. Five relevant aspects were selected and reviewed. A total of seventeen propositions were suggested to investigate how Korean HTSFs evaluate each decision-making procedure. The next chapter will provide operational and measurement method of each element.

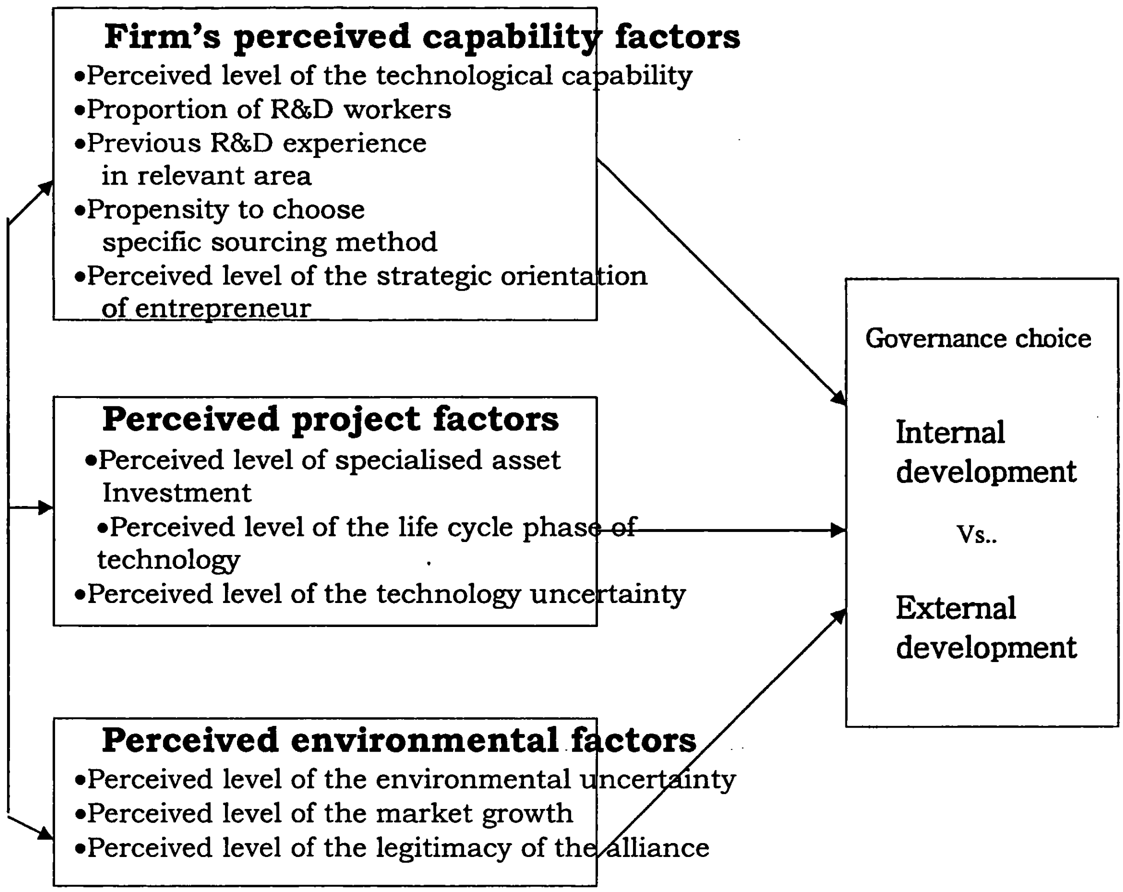
Chapter 6. Operationalisation and measurement

Operationalisation is to attempt to convert the abstract concepts or variables into observable, tangible and measurable dimensions, so that the proposed concepts are testable. This chapter will summarise how to measure the abstract concepts suggested in the previous chapter and test their hypothesised causal relationship with the outcome variables.

6.1 Determinants in stage one (technology-sourcing decision): hypotheses and operationalisation

In the two-stage contingency model, the first stage dealt with how to choose between in-house development vs. external sourcing (technology alliance). Figure 7 depicts the framework on causal relationship between determinants and technology-sourcing modes.

(Figure 7) Determinants of decision-making in the first stage



The following sections are the summary of the measurements in individual determinant items during the first stage of decision-making. (Venkalraman & Prescott 1999, Bourgeois 1980) maintain that a firm's internal and external environmental condition can be more correctly measured by the manager's perception than archival data. Adherent to their approaches, this study will be reliant on the perception of the respondents as a measurement of the concepts.

! Perceived level of the technological capability

Two contrasting hypotheses were suggested.

H1-1: Ceteris paribus, the greater the perceived level of technological capability, the more likely that the decision-makers of Korean high-tech small firm will choose in-house development for new technology development projects
And
H1-1: Ceteris paribus, the greater the perceived level of technological capability, the more likely that the decision-makers of Korean high-tech small firm will choose technology alliance for new technology development projects

This study defines that technological capability of HTSFs indicates the firm's stock of technological capitals including knowledge related to the access, use and innovation of production techniques and product technology and superior management and administrative capacity (Fernandez, et al. 2000). Previous studies have measured the concept by using, for instance, the total number of patents obtained and protected by the law (Mowery, et al. 1998), the amount of R&D investment and quality control capabilities (Lee, et al. 2001), the new product development rate (Deed, et al. 1998) and absorptive capability (Lado & Vozikis 1997). Combining ideas from Deed, et al. (1998), Tidd & Trewhella (1997) and Lee, et al. (2001) research, this study suggests following items to measure the concept.

	Items	much inferior			similar			much superior
Q1	R&D facilities	1	2	3	4	5	6	7
Q2	Management capability	1	2	3	4	5	6	7
Q3	New product (technology) development capability	1	2	3	4	5	6	7
Q4	R&D spending and investment	1	2	3	4	5	6	7

Q5	Number of patent or intellectual properties	1	2	3	4	5	6	7

These items cover financial, managerial, technological and human resources that determine overall technological competence of the HTSFs. The respondents are asked to judge the strength and condition of these resources by the time that they decide the technology-sourcing method for the innovation project.

Evaluating the above items is highly subjective due to the respondent's own belief and ambition. Thus, the respondents are asked to evaluate them by comparing with the conditions of the leading competitor firm (either in domestic or foreign market) in the same industry. They will be measured in interval scale (7-point Likert scale); 1 means that the perceived technological capability is much inferior to the leading competitor, 4 as similar and 7 as much superior. As a multivariate measurement, this study will use a summated scale (average score) of the five items as representative of the respondent's overall perceived level of the technological capability. As the average figure is higher, the respondent's perceived level of technological capability is higher. The summated scale is recommended as it enables several indicators to represent a single concept (Hair, et al. 1998).

Hypothesis 1-2 was:

H1-2: Ceteris paribus, the greater the proportion of R&D workers, the more likely that the decision-makers of Korean high-tech small firm will choose in-house development for new technology development projects
And
H1-2: Ceteris paribus, the greater the proportion of R&D workers, the more likely that the decision-makers of Korean high-tech small firm will choose technology alliance for new technology development projects

This hypothesis was designed to supplement hypothesis 1-1. The dominant studies use the total number of R&D workers as an objective measurement of technological capability of a firm (i.e., Pisano 1990). However, an absolute number of R&D workers may not represent the technological capability because technology-intensive small firms do not employ R&D workers in proportion with the total number of employees; some small firms hire very large numbers of R&D workers while some large ones may hire relative small numbers, depending on the strategic orientation, previous achievement and status of technological leadership. Thus, instead of using the absolute number of R&D workers, this study adopts the proportion of R&D workers at the time that the Korean HTSFs planned the technology projects. The proportion of R&D workers can be achieved by the total number of R&D workers divided by the total number of employees. So, the proportion of R&D workforce ranges from continuum 0 to 1, closer to 1 indicating a higher R&D workers rate, thus, more technologically-capable and knowledge-intensive.

!Previous in-house R&D experience in relevant area

The study hypothesised that:

H1-3: Ceteris paribus, the more previous in-house R&D experience in similar areas, it is more likely that the decision-makers of Korean high-tech small firm will choose in-house development for new technology development projects

Many scholars contend that familiarity of the new project by the firm's previous in-house effort will lead the firm into choosing the same method to undertake the project (see, Burgel & Murray 2000; Veuglers 1997 and Gulati 1995). However, how can we identify the relatedness of the firm's incumbent new project with its previous in-house technological experience? In order to trace the relatedness, Mowery, et al. (1998) used a citation index of the newly patented technology of a firm and its relatedness to the past one; if both share the same citation numbers, they are related to some extent. Unfortunately, this method was not useful to this study; many small firms do not always register their new technologies in the Patent Office and many projects are still waiting to be registered once they are completed. Therefore, this study will directly ask respondents whether their new project in question is similar or related to their previous in-house development experience. Nominal scale will be used to measure, for instance,

- 1 = if yes
- 2 = if no

The group coded 1 is for those who responded YES while the group coded 2 is for those who responded NO. In the analysis, 1 will be coded as 0 and 2 as 1. The numbers 1 and 2 have no intrinsic value other than to assigning one of two non-overlapping categories. A similar measurement method is found in Pisano's (1990) and White's (2000) studies.

!Propensity to choose specific technology-sourcing modes (routine response)

The study hypothesised that:

H1-4: Ceteris paribus, the more often the decision-makers of Korean high-tech small firm chooses specific development mode for new technology development previously, the greater the likelihood that they will choose the same method over again

This hypothesis is based on the assumption that a firm's strategic-decision making tends to be history-dependent. To measure it, Fairbank and Steensma (1999) recommend that the propensity to choose specific sourcing method can be measured by the respondent's filling the technology procurement method in terms of percentage, for instance, the percentage of such as joint venture, licensing and internalisation out of the total number of technology projects. However, pre-test shows that the majority of respondents felt heavily annoyed by the fact that they had to give the answer in percentage terms for every individual sourcing mode. Some did not recollect clearly. This deteriorated the response rates. To aid the respondent's memory with simplicity, the following question items are used instead.

•Total number of technology development projects via in-house development
•Total number of technology development projects prior to the new technology development project in question.

The former is divided by the latter. Then, the figure will range the continuum between 0 and 1 where the figure closer to 1 implies that the firm tends to rely more on in-house development method prior to new technology development projects in question. The total number of previous in-house development is only asked because in-house development (as baseline mode of technology-sourcing mode among others) is very typical and common among small firms and the numbers of joint ventures and licensing are likely to be very small. This is the alternative but simpler way to assess the propensity to use certain sourcing modes repeatedly.

!Perceived level of the strategic orientation of the entrepreneur (entrepreneurial orientation)

The study hypothesised that:

H1-5: Ceteris paribus, the greater the perceived level of the entrepreneurial strategic orientation that the decision-makers of Korean high-tech small firm have, the greater the likelihood that they will choose technology alliance for new *technology development project*

Entrepreneurial strategic orientation reflects the extent to which the founder or decision-makers are taking up an aggressive and proactive strategic posture against business-related risks, innovation and change in order to obtain competitive advantage and compete successfully with other firms. To measure its diverse dimensions, this study adopts tools suggested by Miller & Friesen (1982), Covin, et al. (1990) and Covin & Slevin (1990). They assess the level of strategic orientation of a high-tech small firm in terms of three dimensions: product innovation, proactiveness and risk-taking vis-à-vis its competitor. Similar to them, this study will use nine measurement items, which will be measured in interval scale (7-point Likert scale).

Q1	Our firm made a strong emphasis on the marketing of tried and true products or services	1 2 3 4 5 6 7	Our firm make a strong emphasis on R&D, technological leadership and innovations
Q2	Our firm has a strong proclivity for low-risk projects	1 2 3 4 5 6 7	Our firm has a strong proclivity for high-risk projects
Q3	Our firm typically responds to actions which competitors initiate	1 2 3 4 5 6 7	Our firm typically initiated actions which competitors then respond to
Q4	Owing to the nature of the environment, it is best to explore it via timid, incremental behaviour	1 2 3 4 5 6 7	Owing to the nature of the environment, bold wide-ranging acts are necessary to achieve the firm's objectives
Q5	Our firm is very seldom the first business to introduce new products/services, administrative techniques, operating technologies, etc.	1 2 3 4 5 6 7	Our firm is very often the first business to introduce new products/services administrative techniques, operating technologies, etc.
Q6	Our firm had no new lines of products or services during the past 5 years	1 2 3 4 5 6 7	Our firm had very many new lines of products or services
Q7	Our firm typically seeks to avoid competitive clashes, preferring a "live-and-let-live" posture	1 2 3 4 5 6 7	Our firm typically adopt a very competitive, undue-the-competitor" posture
Q8	Our firm typically adopts a cautious, "wait-and-see posture in order to minimise the probability of making costly decision	1 2 3 4 5 6 7	Our firm typically adopts a bold, aggressive posture in order to maximise the probability of exploiting potential opportunities

Items 1,2 and 3 reflect the entrepreneurial strategic posture to the product innovation, items 4, 5 and 6 to the proactiveness and items 7, 8 and 9 to the risk-taking. Each item consists of a pair of statements which represent the two extremes of aspects of entrepreneurial strategic orientation that account for the time when the project in question was initiated. The respondents have to indicate the number in each scale (1 to 7) that best approximate their actual conditions at the time of making the technology-sourcing decision. The average score of the nine items will be used as the attitude of the respondent's perceived strategic orientation. As the indicated figure is higher, the respondent's perceived level of entrepreneurial strategic orientation is higher.

!Perceived level of the specialised asset investment (Technology/product-specific asset)

The study suggested two contrasting hypotheses that:

H1-6: Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makers of Korean high-tech small firm will choose in-house development for new technology development project.
And
H1-6: Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makers of Korean high-tech small firm will choose technology alliance for new technology development project.

The perceived level of specialised asset investment implies to what extent the Korean HTSFs have to make specialised (specific) investment for the new technology project that cannot be easily redeployed to another transaction without sacrifice of the value (Besanko, et al. 1998).

To measure the respondents' assessment of their perceived level of specialised asset investment in the technology projects, the following 10 items will be used, using interval scale (7-point Likert scale) measurement. These are adopted and modified from, and Arino (2001), Robertson & Gatignon (1998) and Heide & John (1990).

	Items	Strongly disagree			neutral			Strongly agree
Q1	Our firm dedicated high levels of personnel to the project	1	2	3	4	5	6	7
Q2	Our firm dedicated high level of professional know-how to the project	1	2	3	4	5	6	7
Q3	Our firm dedicated a significant amount of plant and equipment to the project	1	2	3	4	5	6	7
Q4	Our firm dedicated high levels of financial resources to the project	1	2	3	4	5	6	7
Q5	My firm dedicated a major marketing commitment to the project	1	2	3	4	5	6	7

Q6	The project was very significant to the core competence of my firm	1	2	3	4	5	6	7
Q7	It was very difficult to re-deploy the equipment for other use, once the project is stopped	1	2	3	4	5	6	7
Q8	Once people and equipment were redeployed for other use, their values are highly depreciated	1	2	3	4	5	6	7
Q9	The use of technological know-how acquired in the project was not much use to the other project	1	2	3	4	5	6	7
Q10	The level of the product (technology) sophistication was very high	1	2	3	4	5	6	7

Items 1, 2, 9 and 10 reflect the level of the specialised investment in human assets including their knowledge and skills needed for the project. Items 3 and 7 measure the level of specialised investment dedicated physical assets specific to the project. Items 4 and 5 try to measure financial and marketing commitment dedicated to the project which are not likely to redeployable to other projects. Items 6 tries to measure the significance of the project to the firm in general terms. Item 8 directly asks to what extent the invested assets can be re-deployable. The respondents are asked to approximate the level of specialised assets invested for the project at the time that the technology-sourcing decision was made. The average score of all items will be used as an indication of the respondent's perceived level of specialised investment assets. As the indicated figure is higher, the respondent's perceived level of specialised asset investment is higher.

!Perceived level of the life cycle phase of technology (stage in technology life cycle)

Two contrasting hypotheses were suggested:

H1-7: Ceteris paribus, as the perceived phase of technology life cycle reaches the mature stage, the decision-makers of Korean high-tech small firm is more likely to choose in-house development for technology development project.
and
H1-7: Ceteris paribus, as the phase of technology life cycle reaches the mature stage, the decision-makers of Korean high-tech small firm is more likely to choose technology alliance for new technology development project

For simplification, the technology life cycle is divided into four phases:

introduction, development, growth and maturity. Pre-testing shows that these four stages are found to be easier for respondents to conceptualise than any other classifications such as fluid, transition, specific and mature stage. A brief description for each stage borrowed from Covin and Slevin (1990) is suggested in the questionnaire, as seen below.

High-tech small firms may offer products or technology which are new and innovative, familiar and widely used, or old and possibly approaching obsolescence. That is, firms may compete on the basis of products or technology, which are in various stages of their life cycle. Please indicate where your new technology or product intended to develop was located in each of the life cycle stages. Keep in mind that this is an industry-level concept. For example, a firm could introduce a new technology/product that is in the mature stage of its life cycle. It would then fall in the maturity category.	
Introduction stage	Products or technology in this stage are unfamiliar to many potential uses and industry-side demand for these products or services is just beginning to grow
Growth stage	The total industry-wide demand for products or services in this stage is growing at a rate of 10% or more annually
Mature stage	Product or services in this stage are familiar to the vast majority of prospective uses and industry-side demand for these products or services is relatively stable
Decline stage	The total industry-side demand for products or technology in this stage is decreasing at a more or less steady rate

Borrowing and revising the approaches of Brockhoff (1992) and Kurokawa (1997), this study will measure the technology life cycle based on a five point scale where 1 identifies a complete new stage, 2 for the introductory stage, 3 for the growth stage, 4 for the mature stage and 5 for the decline stage. The perceived phase of technology life cycle is measured in nominal scale but will be treated as interval scale for statistical analysis. The greater the number, the greater the perceived phase of technology life cycle.

!Perceived level of the technology uncertainty

The hypothesis was that:

H1-8: Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firm will choose in-house development for new technology development project

And
H1-8: Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firm will choose technology alliance for new technology development project

Technology uncertainty consists of technical uncertainty (whether the technology will work as it is designed) and commercial uncertainty (whether the customer's expectations would be reached and their satisfaction accomplished). The measurement of technology uncertainty is composed of five items, each measured in interval scale (7-point Likert scale). The measurement is adopted and modified from Weber and Walker (1984), and Steensma and Fairbank (1999), as seen below.

	Items	Strongly disagree			neutral			Strongly agree
Q1	We were confident that this technology which the project will develop would achieve our market goal	1	2	3	4	5	6	7
Q2	We were confident that this technology would meet our technical expectation	1	2	3	4	5	6	7
Q3	We were confident that this technology would meet customer demand	1	2	3	4	5	6	7
Q4	It was confident that this technology would work as it was intended and designed technologically	1	2	3	4	5	6	7
Q5	We were confident that this technology would be a commercial success	1	2	3	4	5	6	7

The measurement taps into both uncertainties associated with engineering and design as well as commercial success. Item 1 directly asks respondents to what extent they are confident about their project. Item 2 and 4 are specifically focused on technical uncertainty while item 3 and 5 on commercial uncertainty. All items are reverse-coded to prevent response bias that results because some individuals tend to agree with all questions or to concur with a particular position. So, the higher the scale, the smaller the perceived technology uncertainty. The average score of the five items will be deemed to be the attitude of the respondent's perceived technology uncertainty.

!Perceived level of the environmental uncertainty

Two contrasting hypothesis were suggested:

H1-9: The greater the perceived level of environmental uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project
And
H1-9: The greater the perceived level of environmental uncertainty, the greater the likelihood that the decision-makers of high-tech small firms will choose technology alliance for new technology project

The underlying source of the perceived environmental uncertainty stems from unpredictable demand, competitor's behaviour and possible discontinuity of existing technology. The measurement of perceived environmental uncertainty is composed of eight items, each measured in interval scale (7-point Likert scale). The measurement is adopted and modified from Miller and Friesen (1982), Bantel (1998) and Robertson and Gatignon (1997).

	Items		Items
Q1	Our firm rarely change its marketing practices to keep up with the market and competitor	1 2 3 4 5 6 7	Our firm must change its marketing practices extremely frequently (e.g., semi-annually)
Q2	The production/service technology is not subject to very much change and is well established	1 2 3 4 5 6 7	The modes of production/service change often and in a major way
Q3	The rate at which /technology/products/services are becoming obsolete in the industry is very slow	1 2 3 4 5 6 7	The rate of obsolescence is very high
Q4	Demand for product and consumer tastes are fairly easy to forecast	1 2 3 4 5 6 7	Consumer demand and tastes are almost unpredictable
Q5	Actions of competitors are quite easy to predict	1 2 3 4 5 6 7	Actions of competitors are unpredictable
Q6	The environment is very safe and Is of little threat to the survival and well being of the firm	1 2 3 4 5 6 7	The environment is very risky and one false step could mean my firm's undoing
Q7	There is no severe competition with other firms	1 2 3 4 5 6 7	There is very severe competition with the other firms
Q8	Our firm can control and manipulate the environment to its own advantage, such as a dominant firm has in an industry with little competition and few	1 2 3 4 5 6 7	A dominant environment in which our firm's initiatives count for very little when up against the tremendous political, technological or competitive forces

	hinderances		

Items 1, 4 and 8 reflect perceived demand uncertainty; 5, 6 and 7 perceived competitive uncertainty and 2 and 3 perceived technological uncertainty. Each of the items consists of a pair of statements representing two extreme aspects of the perceived industrial environment by the time when the project was initiated. The respondents should circle the number that best approximates their actual perception. Similar to measurements used in H1-5, the H1-9 uses the Osgood's semantic differential measurement technique, helping the respondents find the scaling easy and visually convenient. The average score of the eight items will be determined to be the attitude of the respondent's perceived environmental uncertainty. As the indicated figure is higher, the respondent's perceived level of environmental uncertainty is higher.

!Perceived level of the market growth

Two contrasting hypotheses were suggested:

H:1-10: Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the decision-makers of Korean high-tech small firm will choose in-house development for the new technology development project
And
H:1-10: Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the decision-makers of Korean high-tech small firm will choose technology alliance for new technology development project

Drawing on the McDougal, et al. (1994) and Robertson and Gatignon (1997), the following six items, using 7-point Likert scale will be used to measure the concept at the time that the technology-sourcing decision was made. These question items are focused on how the respondents perceive their incumbent market growth potential in terms of customer growth, variation of the product categories and financial investment opportunity.

	Items	Strongly disagree			neutral			Strongly agree
Q1	Customer demand was growing rapidly	1	2	3	4	5	6	7
Q2	Demand of the firm's product category was volatile	1	2	3	4	5	6	7
Q3	Product category growth was rapidly growing	1	2	3	4	5	6	7

Q4	Our playing industry field was a high growth market	1	2	3	4	5	6	7
Q5	There were a lot of unexplored areas within the industry	1	2	3	4	5	6	7
Q6	There were rich opportunities in new investment and marketing in the field, thus we increase the financial spending	1	2	3	4	5	6	7

The average score of the six items will be taken as a respondent's perceived level of the market growth. As the indicated average score is higher, the respondent's perceived level of market growth is higher.

!Perceived level of the legitimacy for alliance (pressure pushing firms to pursue a cooperative strategy)

The study hypothesised that:

H1-11: Ceteris paribus, the greater the perceived level of legitimacy of the alliance (pressure pushing firm to pursue cooperative strategy), the greater the likelihood that the decision-makers of Korean high-tech small firm will choose technology alliance for new technology development project.

To measure the extent of perceived legitimacy for technology alliance at the time of deciding incumbent technology-sourcing strategy, this study designs the following five items, using an interval measurement scale in 7-point Likert scale. This measurement items were based on the interview with the industry experts and two managers of Korean HTSFs.

	Items	Strongly disagree			neutral			Strongly agree
Q1	Many firms in the industry seemed to conceive that technology alliance is a strategic necessity for the success of technological innovation and competitive advantage of a firm	1	2	3	4	5	6	7
Q2	We felt pressured or threatened when we hear the announcement that competitors or firms in the same industry launch a new technology alliance relationships	1	2	3	4	5	6	7
Q3	Strategic technology alliance became routine and in fashionable in the telecommunications industry	1	2	3	4	5	6	7

Q4	It was most often observed in the industry that strategic alliance is formed with other objectives rather than developing new technology (e.g., name recognition, reputation spillovers, networking effect, corporate image, stock price increase)	1	2	3	4	5	6	7
Q5	We believed that strategic technology alliance would give a positive effect on the high tech firms and, if possible, we wish to form as many technology alliance as possible	1	2	3	4	5	6	7

Question items 1, 2 and 3, directly ask and measure the extent of how the decision-makers are keen to investigating other firms' alliance practises for the same issue. The recent criticism asserts that increasing numbers of Korean HTSFs hastily announce joint R&D contracts without establishing specific plans to proceed with the cooperative research project (Dong-a Ilbo 2004). This implies that technology alliance is prevalent among Korean venture firms for reputation effects, corporate image and stock price increase, other than its original aim. Item 4 reflects the additional source of why many Korean ventures are pressured to engage in technology alliance. On the other hand, a media spot-light on, or coverage of a huge success story of venture firms and the positive effect of their various technology alliances, acts as a legitimate inspiration for many other firms to follow the same with the optimistic view of what he same practice will bring for themselves. Item 5 reflects this point. The respondents are asked to circle the number in each scale that best approximates the stated condition of legitimacy of technology alliance at the time that the technology-sourcing decision was made. The average score will be used as a perceived legitimacy for alliance. As the indicated figure is higher, the legitimacy level respondents perceive is higher.

The followings are the measurements of the three controlling variables.

!Perceived level of the government support

H2: Ceteris paribus, the greater the perceived level of governmental support for technology cooperation, *the greater the likelihood that the Korean high-tech small firm will choose technology alliance for new technology development*

Various Korean government-support policies can be summarised in six major assistance policies as seen in the question items 1 to 6 below. Respondents are asked to circle the number in each scale which indicates to what extent they are satisfied with the government's support and assistant programme when they initiate new technology development.

	Items	Strongly un-satisfy			neutral			Strongly satisfy
Q1	Tax incentive or deduction	1	2	3	4	5	6	7
Q2	Government fund and any other financial Resource assistance	1	2	3	4	5	6	7
Q3	Government sponsored network association promoting information exchange among industry, universities and research institute	1	2	3	4	5	6	7
Q4	Governmental support for partner searching and evaluation and promoting international technology transfer	1	2	3	4	5	6	7
Q5	Relaxing anti-trust law and promoting intellectual property policy	1	2	3	4	5	6	7
Q6	Supporting human resources, technological training and physical facilities	1	2	3	4	5	6	7

The average score will be used as the perceived level of government support. As the indicated figure is higher, the respondent's perceived level of government support is higher.

!Perceived level of the financial costs of development

H3: Ceteris paribus, the greater the perceived level of developing costs of carrying out the project, the greater the likelihood that the Korean high tech small firm will choose technology alliance for new technology development

While considering the R&D investment, production and personnel expenses, the respondents are asked to estimate the developing costs of the new product technology project. A single item directly asks the expected developing costs, measuring in interval, 7-point Likert scale where 1 indicates the average expected developing costs and 7 indicates very high expected developing costs.

Average			high			Very high
1	2	3	4	5	6	7

!Firm size

The sale size in terms of Korean currency (Won) will be used as the firm size by the time the new technology development project is initiated. Some respondents preferred to specify it in categorical number instead of the precise figure. Therefore, this study will use each category as firm size in which 1 indicates annual sale size between £250,000-£500,000, 2 is £500,001-£2,500,000, 3 is £2,500,001-£5,000,000, 4 is £5,000,001-£10,000,000 and 5 is £10,000,001-£40,000,000.

!Dependent variable

Technology-sourcing decision is the unit of analysis of the study, thus, it is used as a dependent variable. Unlike other studies analysing managers' decision-making based on the researcher's hypothesised scenarios (Tyler & Steensma 1998), this study allows only one representative decision-making for a single firm, based on its real experience. As noted earlier, two choices of decision-making are ultimately available, either preceding the project using the existing resources internally within the firm or together with another entity. The formal includes in-house venture, internalisation with acquisition of other firms and establishing wholly-owned subsidiaries. The latter include cooperation based on equity or non-equity sharing. Exchange through spot market is considered cooperation and external sourcing, such as licensing. The decision-making is defined as a dummy variable in which

•1 = if the firm chooses technology alliance
•2 = if the firm chooses in-house development

1 is coded 0 and 2 is coded 1 in the statistical analysis.

Logistic regression analysis is appropriate when the dependent variable is binary and the underlying assumption of multivariate normality is not met (Erammilli 1992)[9]. The chance of Korean HTSFs choosing an in-house development over not choosing in-house development (technology alliance) can be termed in probability p, if we name it. Not choosing in-house

[9] Logistic regression is a combination of multiple regression and multiple discriminant analysis, in that one or more independent variables are used to predict a single dependent variable. What distinguishes a logistic regression analysis from multiple regression is that the dependent variable is non-metric, as in discriminant analysis. Logistic regression analysis is also distinguished from the discriminant analysis in that it accommodates all types of independent variables (metric and non-metric) and does not require the assumption of multivariate normality. In this study, the dependent variable is technology-sourcing decision between in-house development vs. technology alliance, and the objective of the study is to understand the differences in decision and to predict the likelihood that an entity (a Korean high-tech small firm) will belong to a particular decision based on several metric and non-metric independent variables.

development will be probability 1-p. However, as the underlying probability p is not a linear function of the predictors, the log-odds transformation of p (logistic transformation of p) makes it a linear additive function of the independent variables X_p. So, the logistic regression model can be written:

$$Log_e(p/1-p) = Logit^{\wedge} = \alpha+\beta_1X_1+\beta_2X_2+\dots\dots\dots+\beta_pX_p$$

X_1, X_2, ... X_p are the explanatory variables derived from internal capability, external environment and project attributes. β_1, β_2, ... and β_p are the corresponding coefficients and α is the intercept. To measure the fitness of the parameter of the model, the Maximum Likelihood Estimation (MLE) method instead of the Ordinary Least Square (OLS) method is used[10]. The regression coefficients in the logit equation estimate the impact of the explanatory variables on the probability that the MLE subunit will be a wholly-owned subsidiary (Luo 2001). The significance of the coefficient can be estimated by the coefficients divided by the corresponding standard error. As a rule of thumb, when the score is larger than 2, the coefficient is significant at 5% of significance.

This equation allows us to estimate the logged odds at Y=1 (if the respondents are choosing in-house development). We can transform the logits back into the probability of an occurrence of Y=1 once we have estimated the regression coefficients in logit units. The formula is that:

Probability of choosing in-house development:

$$P\ (mode=1) = 1/(1 + e_{-y}) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

where y is a linear function of all proposed factors affecting dependent variables. Y can be written in equation form:

$$y=Log_e(p/1-p)=Logit^{\wedge}=\alpha+\beta_1X_1+\beta_2X_2+\dots\dots\dots+\beta_pX_p \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

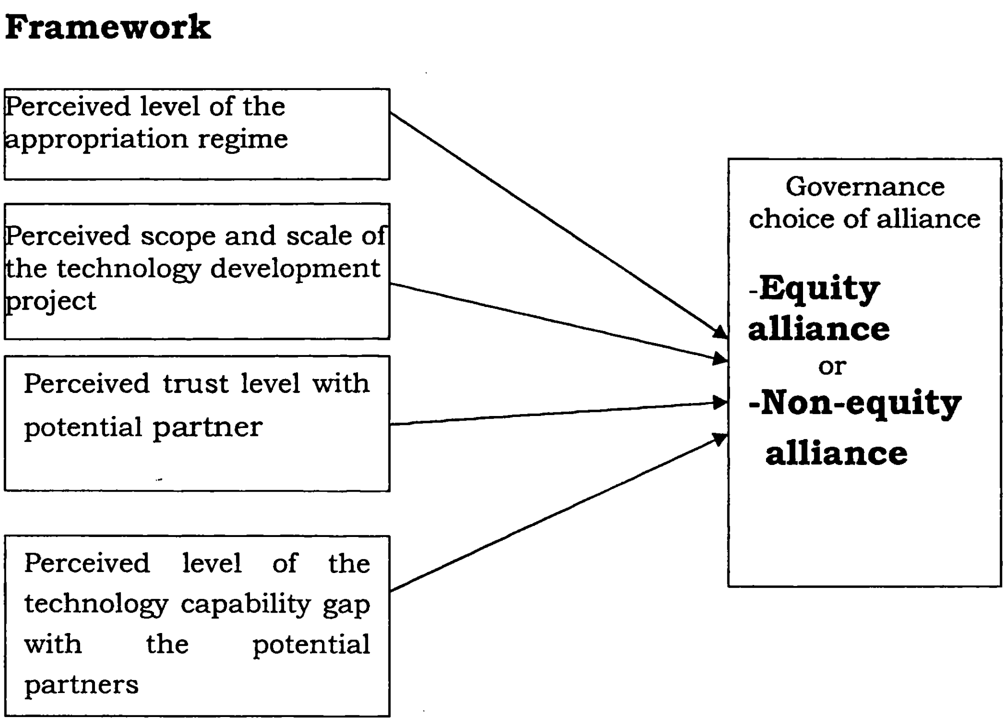
The probability of Korean high-tech small firms choosing an in-house development in preference to technology alliance can be modelled as a function of the main effects and controlling factors.

[10] The adequacy of the model is assessed by means of the chi-square test; generally, the larger the chi-square value and the smaller the associated p-value, the better the model is. That the model is significant and fit means that the independent variables as a group are successful in differentiating between the choice of the dependent variable (in this study's case, between in-house development vs. technology alliance choice in Korean high-tech small firms).

6.2 Determinants in stage two (technology-sourcing decision): hypotheses and operationalisation

The second stage is how to choose between equity alliance vs. non-equity alliance. Figure 8 depicts the framework on the causal relationship between determinants and appropriate choices.

(Figure 8) Determinants of decision-making in the second stage



The following is the measurement of the above observable variables.

!Perceived level of the appropriation regime

This study hypothesised that:

H1-12: Ceteris paribus, the weaker the perceived level of intellectual property regime (appropriation regime), the greater the likelihood that the decision-makers of Korean high-tech small firm will choose equity alliance for new technology development project

Here, the study tries to measure to what extent the Korean HTSFs anticipate that they are able to seize the return from their contribution to cooperative efforts. Based on the measurement used in the study of Jones, et al. (2000), Gulati (1995), Oliver (1990) and Pisano (1990), the following five items with interval scale (7-point Likert scale) will be used to measure the concept.

	Items	Strongly disagree			Neutral			Strongly agree
Q1	Core product or technology of our firm is well protected by Korean patent law (reverse)	1	2	3	4	5	6	7
Q2	The intellectual property of our firm is likely be to be tacit and un-codifiable in nature	1	2	3	4	5	6	7
Q3	Misappropriation activity would be more likely to occur once the cooperation with the partner is initiated	1	2	3	4	5	6	7
Q4	It is difficult to state clearly the amount of knowledge exchanged with the cooperating partner	1	2	3	4	5	6	7
Q5	Disputes regarding technological leakage or free-riding are common in the industry	1	2	3	4	5	6	7

Item 1 directly questions whether patent law is powerful and efficient enough to protect intellectual capital of the responding firms. The power of patent law is a key to estimating the protectiveness of intellectual capitals in the interfirm relationship. Items 3 and 5 directly measure the respondents' perception of the general condition of the appropriation regime surrounding the technological cooperation environment. When knowledge invested in the relationship is highly tacit, not easily codifiable and definable, the chances for transmitting and internalising it without mutual consent are high. Items 2 and 4 measure the level of tacitness of exchanging knowledge and boundary of which part of knowledge is attributable to which party, assuming that high tacitness and ill-defined knowledge contribution to a deteriorating appropriation regime. The item 1 is reverse coding. The average score of the five items will be used as a perceived appropriation regime within the cooperative relationship at the time of deciding the structure of the technology alliance. As the indicated figure is higher, the respondent's perceived level of appropriation regime is weaker.

!Perceived scope and scale of the technology development project

The hypotheses H1-13 and H1-14 try to measure how the perceived complexity of the cooperative activities in the technology development project influences the governance choice of technological cooperation.

H1-13: Ceteris paribus, the broader the perceived scope of cooperative activity (not only including R&D activities but also manufacturing, marketing and/or supply activities as well), the greater the likelihood that the decision-makers of Korean high-tech small firm will choose an equity alliance for new technology development project

To measure the perceived scope of the project, a categorical scale is be used. 1 is coded when the respondent's alliance activity covers not only the R&D activities but also production, marketing and supplying activities, while 2 is coded when the alliance activity covers joint R&D only).

•1 = If the alliance activity covers only R&D
•2 = If the alliance activity is not limited to R&D but also production, marketing and supplying activity

Similar logic can be applied to the next hypothesis:

H1-14: Ceteris paribus, the broader the perceived scale of cooperative activity (not only limited to one technology but also covering range of products/technologies), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project

1 is coded when the respondent's alliance activity covers only one type of technology/product while 2 is coded when the alliance activity covers only one product/technology.

•1 = If the alliance activity covers only one type of technology/product
•2 = If the alliance activity covers more than two types of technology/product

!Perceived trust level with the potential partner

This study hypothesised that:

H1-15: Ceteris paribus, the stronger the perceived trust level with the potential partner, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose non-equity alliance for new technology development project

This study adopts and modifies the instrument used in studies by Cook and

Wall (1980) and Rao and Schmidt (1998), to measure perceived trust level with the potential partner. The respondent is asked to indicate their perception of the trustworthiness and reliability of a potential partner when they structure new technology cooperation with it. A seven-point interval scale (Likert-scale) is used.

	Items	Strongly disagree			neutral			Strongly agree
Q1	We thought that partner firms were sincere in this attempt to meet our point of view	1	2	3	4	5	6	7
Q2	We thought that our partner firm could be trusted to make sensible decisions for the future of the alliance	1	2	3	4	5	6	7
Q3	We thought that our partner was an economically and socially efficient organization	1	2	3	4	5	6	7
Q4	We thought that our partner would be quite prepared to gain an advantage through deception (reversed)	1	2	3	4	5	6	7
Q5	We thought that our partner could be relied upon to keep the promises	1	2	3	4	5	6	7
Q6	We thought that our partner would lend us a helping hand if we run into problems	1	2	3	4	5	6	7
Q7	We thought that our partner would put us in danger due to negligence and carelessness on the job (reversed)	1	2	3	4	5	6	7
Q8	We thought that our partner has the skills and qualifications for the job	1	2	3	4	5	6	7

The perceived trust level can be measured in three dimensions. Item 4 directly asks the likelihood of the potential partner deceiving the respondent. Items 1, 5 and 6 focus on the cooperative and accommodative level of the potential partner with the respondents on the mutually-agreed and committed matters. Items 2, 3, 7 and 8 are more focused on cooperative task-level issues. Achieving alliance objectives necessitates timely but rational decision-making, proper qualification of skill to the task, efficient organisational structure and tenacity to the objective of each individual partner. Lack of partner's will and ability to the cooperative task casts doubt on the chances of things running smoothly together. Items 4 and 7 are reverse coded. The average score will be used for perceived trust level with the potential partner. As the figure indicated is higher, the respondent's perceived trust level with the partner is higher.

!Perceived the technological capability gap with the potential partner

This study suggested two contrasting hypotheses:

H1-16; Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project.
and
H1-16; Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an non-equity alliance for new technology development project.

Referring to the Jones et al. (1997) and Arts and Brush (2000) study, the following six items with interval scale (7 point Likert scale) are elicited to measure technological capability gap with the partnering firm. The average score will be used as the perceived level of technological capability gap with the potential partner. As the figure indicated in the scale is larger, the respondent perceives that their firms are relatively superior position to the potential partner, widening the technology capability gap.

	Items	Much Inferior			similar			much superior
Q1	Developing core technology	1	2	3	4	5	6	7
Q2	Modifying related technology	1	2	3	4	5	6	7
Q3	R&D workforces capability	1	2	3	4	5	6	7
Q4	R&D facilities	1	2	3	4	5	6	7
Q5	Ability to collecting related technological information	1	2	3	4	5	6	7
Q6	Ability to absorb knowledge transferred or transmitted	1	2	3	4	5	6	7

!Dependent variable

Mode of technology alliance is the unit of analysis in the second stage, thus, it is used as a dependent variable. Equity alliance includes all types of cooperation with equity-sharing. Joint venture and minority equity ownership are the most common types. Non-equity alliance includes all types of cooperation without equity sharing. The most common types are R&D contract, cross-licensing, joint development and production contract. For the purpose of analysis, the distinction will not be drawn between various types of equity alliance and non-equity alliance. As only two choices are available, logistic regression will be used. The decision-making is defined as a binary mode in which

•1 = if the firm chooses equity alliance
•2 = if the firm chooses non-equity alliance

1 is coded 0 and 2 is coded 1 in the statistical analysis.

Conclusion

A total of 16 hypotheses have been suggested. Primary data, instead of secondary data, will be used for testing hypotheses. Thus, careful measurement tools are essential to correctly gather information from the respondents. Many measurement tools are adapted and modified from the previous studies to ensure validity and reliability. The summary of the operationalisation and measurement for each hypothesis can be seen in appendix 2.4. Next chapter will be focused on construction of converting these measurement items into questionnaire. In addition, the process of how the questionnaire has been distributed and collected from its distribution will be described.

Chapter 7: Data collection and survey result

Having established the theoretical framework and working hypotheses, this chapter will summarise the process of database construction, questionnaire design and data collection. Then, based on the data collected, descriptive analysis of the questionnaire survey results will be presented. This includes the characteristics of the responding firms, their technological innovation activities and their formal and informal technological cooperation activities during the past five years. Lastly, the study will address the impact of the technology alliance on Korean high-tech small firms in terms of how it contributes to improving the innovative capability of the firms.

7.1 Database construction

The Korean telecommunications industry is one of the most knowledge intensive industry sectors in Korea and technology cooperation is most widely employed in this industry. In Chapter 3, this study noted that the telecommunications industry consists of three large sub-sectors: telecommunications-related software, telecommunications equipment and telecommunications service. This study does not include telecommunication service as a research target because it is more service-oriented than R&D-oriented. Both telecommunications equipment and telecommunication-related software sector can be further refined into the following seven sub-sectors which constitute the final subject of this study.

Telecommunication equipment manufacturing
Industry communication equipment manufacturing
Communication related household electrical appliances
Internet/solutions
Software/Hardware
Semiconductor/accessories (parts)/material
ETC.

Various data provides an inconsistent total number of HTSFs in this industry. Roughly, there are about 20,000 HTSFs in the industry, according to the 'Company List in Telecommunications and Information Industry' published by the Electronic Times in 2002. However, not all of them are significantly important to the objective of this study; many of them are nascent and too small-scale. Establishing an adequate list of population is essential to prevent systematic (non-sampling) error. To establish exhaustive and appropriate lists of relevant population, this study used several major database resources dealing with Korean HTSFs such as: the Database of the Korea Federation of Small and Medium Businesses (KFSB), KOSDAQ stock market registered IT venture firms, Database of the Small and Medium Business Association (SMBA), Database of the Promising Information and Communication Companies Association (PICCA), Database of the Electronic and Telecommunications Newspaper, Database of the Korea Chamber of Commerce and Industry (KCCI) and Database of the Korean Mobile Association. Te following table sums up the number of HTSFs in the six major databases.

(Table 34) Total number of Korean high-tech small firms as in 2002

Source of the high tech small firms in telecommunications industry	**Number of IT firms listed**
Database of the Korea Federation of Small and Medium Businesses (KFSB)	1,448
KOSDAQ registered venture firms in IT sectors	250
Database of the Small and Medium Business Association (SMBA)	3,450
Database of the Promising Information and Communication Companies Association (PICCA)	810
Database of the Electronic and Telecommunications Newspaper	1,560
Database of the Korea Chamber of Commerce and Industry (KCCI)	488
Database of the Korean Mobile Association	580
Total	**8,586**

A total of 8,586 firms were identified. However, many firms appear in more than one of the above lists simultaneously. Cancelling out all these firms leads to a total of 3,412 firms from the databases. Some of them are not really the telecommunications-related. Possibly, there are more firms not registered in the above database, but this study does not consider them due to the difficulty of data accessibility and their insignificant impact on the industry as a whole.

It is vital to carefully define the target population in postal survey-based empirical study. To make further refinements of the 3,412 population list, several steps were undertaken. The first, selection process was to elicit only the firms that belong to any of the 7 sub-sectors in the telecommunications industry. Second, this study is only concerned those who have carried out R&D or technological innovation activities. In Chapter 3, this study defines technological innovation activity. However, there was no official database exhaustively reporting all of the Korean HTSFs' technology alliance activities in detail. Therefore, this study had to rely on the author's intuition by using the firm's websites, company directory books, newspaper reports and industry magazines. The principle criterion was whether the firm had its own patent, utility model or trademark as a representative of its innovation effort or whether the firm is currently engaged in technology cooperation with another domestic or foreign partner. Finally and most essentially, all elements in the population should meet the following strict criteria.

(Table 35) Population selection criteria

•Firms that have operated in relevant areas, defined as the telecommunications industry and its sub-sectors
•Firms founded before 2000
•Firms with 10 to 400 employees
•Firms orientated towards technology and engaged in cooperation with domestic and foreign firms as of 2000
•Firms with annual sales of between £250,000 and £40 million as of 2001
•Firms with their own R&D departments
•Firms with a history of previous technology development and with intellectual patents and know-how registered in the government bureau
•Firms that are independent, not subsidiaries or incubating firms of large domestic or foreign firms or government-run institutions
•Firms with an identifiable contact address

The study spent some considerable time carefully selecting appropriate players in the population. Many of 3,412 firms were dropped due to incorrect or outdated corresponding telephone numbers, short periods of running of the business, insufficient scale and incubating status (large firm's ownership). Strict selection criteria took many firms out of the potential population group. However, it was necessary procedure; narrower and well-defined population reduces the systematic (non-sampling) error and improve reliability and validity of the data.

Regarding sample size in terms of employees, small and medium firms should be the firms with less than 300 employees, according to the Korean Venture Business Act. However, the number is based on the full-time and permanent employees, excluding part-time or temporary workers. Many venture firms consider full-time and part-time workers together as total employees and notify it in their website and official registration accordingly, trying to have their firms look larger. But, the core employees of the venture firms tend to range between 50-100 full time employees, according to the industry experts. In addition, small venture firms' employee numbers are very flexible in these days so that the figure is not precisely reflected in the government's venture business registration office (more important registration requirement is whether the firm received the venture capitals and the employees are less than 1,000). Considering all these, this study allows rather flexible range of HTSF with size up to 400 employees.

Based on the above selection criteria, a total of 1,160 firms were selected out of 3,412 firms. The selected firms had their own official websites and corresponding addresses. Through their website, the author was able to survey briefly their achievement and technological progress since their establishment, having confidence that these firms represent major HTSFs in the South Korean telecommunications market, in terms of technological innovation and R&D projects. The following is the summary of the total population and their distribution according to the sub-industry sectors.

•Structure of the population

Sub-industry sectors	**No. of firms**
Telecommunications equipment manufacturing	312 (26.9%)
Industry communications equipment manufacturing	186 (16.0%)
Communications-related household electrical appliances	53 (4.6%)
Internet/solutions	188 (16.2%)
Software/Hardware	206 (17.8%)
Semiconductor/accessories (parts)/material	90 (7.8 %)
ETC./others	125 (10.8%)
Total	**1,160 (100%)**

As expected, communications equipment manufacturers make up the largest portion of the total population, accounting for 45 percent. Correct responding addresses and contact persons at top management level were identified. These 1,160 firms were used as the final population to which a carefully designed questionnaire was distributed. Many of the respondents' main corresponding addresses are located in the Greater Seoul area, the capital of South Korean, and some of the larger-sized firms have their R&D centres in the remote areas. However, there were no signs of spatial proximity among the dominant respondents. In fact, there are several IT clusters in the middle- and lower-part of the Korean peninsula, but they were set up to assist local research laboratories and newly-established firms, less than 2-3 years old, which are not part of the sample of this study.

7.2 Data collection

■ Questionnaire design

The questionnaire is an efficient empirical data collection mechanism when the researcher knows exactly what is required and how to measure the variables of the interest (Sekaran 2000). Nevertheless, mail surveys of small firms have notoriously poor response rates, creating the potential for substantial systematic error in the survey of the population. To enhance response rates as well as relevance and accuracy to the question. This study focused three questionnaire design principles: wording, planning of measurement and appearance of the questionnaire.

The wording used should be readily understandable to all respondents. Although the respondents are likely to be well educated with high business acumen, this study tried not to use too much conceptual terminology and jargon. Also, the questions were not phrased in a way that leads the respondents to give the responses that the study would like or want them to give. To do this, "to what extent do you think..." types of questions were framed. This study also mixed positive and negative questions together. Using them together alerts respondents who are not particularly interested in completing the questionnaire and their tendency to mechanically circle the point toward one end of the scale is minimized (Sekaran 2000). But double negatives or too much use of 'not' or 'only' is avoided.

All questions relied on the respondent's retrospective accounts of past technology-sourcing decisions they had made. Two difficulties occur in these types of questions. First, people (busy CEOs or senior managers) tend to forget about their past behaviour or past events, so that the respondents cannot recall the answer to the question. Second, most often the respondents are reluctant to disclose much about their firms' strategic issues such as technology-sourcing and technology alliance. Therefore, open-ended questions, despites their valuable free-answer advantage based on the respondent's own word, are not appropriate. Instead, structured, closed questions were adopted. Closed questions are easier for the respondents to answer as they provide limited but specific alternatives closed to the respondent's own view point. To measure the respondent's attitude and perception correctly, various rating and ranking scales were applied which include categorical, Likert, semantic differential and comparative scale. To aid the respondent's memory, all questions were on the most significant technology-sourcing decision that was made during the past three years from the time that the respondents received the questionnaire. All measure items were borrowed and modified from the previous literature, so that they can be said pre-tested to some extent.

Lastly, the lay out of the questionnaire is highly influential to the response rate of the survey (Zikmund 1991). This study adopted 'funnel technique' where general questions are asked first before specific questions to minimise unbiased responses. In the introduction section, the study disclosed the identity of the researcher, conveyed the purpose of the survey and established some grounds to motivate the respondents to answer the questionnaire willingly and enthusiastically. Confidentiality was assured. The first section contained general questions including the respondent's personal information and the firm's general information. The second section contained the questions on the responding firm's overall pattern of technological cooperative activities. The third section contained the questions specific to the firm's technology-sourcing decision related to the hypotheses testing. The fourth section contained the questions for those who chose technology alliance in the third section. Lastly, brief 'thank you' comments were included in the last section.

■ First wave of data collection (pilot study)

The pilot study is defined in two different ways. It refers to a so-called feasibility study which is a small-scale version or trial-run in preparation for the major study; or it refers to a pre-testing or trying out of a particular research instrument (i.e., questionnaire) (Surrey University pamphlet). The advantage of the pilot study is that it might give advance warning about where the main research project could fail, where research protocols may not be followed or whether proposed methods or instruments are inappropriate or too complicated (pamphlet). This study applied the pilot study in both ways.

The first phase of the pilot study was a feasibility study, which was carried out prior to distributing the complete questionnaire design. Discussion with one Korean academic researcher who was familiar with the nature of this study was undertaken. The author found that the issues constructed in the theoretical model were substantially significant at management level among the Korean HTSFs. At the same time, a structured interview and free conversation with the senior managers of two major Korean HTSFs were held. The key investigation area was whether the assumption of the two stage contingency model is a realistic approach to understand parishioner's technology-sourcing behaviour. Two comments were particularly helpful in supporting the assumptions which the study' put forward earlier. A managing director of a five-year old Korean HTSF explicitly expressed his view of strategic planning for new technology development project:

> "Strategic formulation is a on-going and systematic process because we work as a close team... we basically arrive at where we think the future lies and the directions we should drive in... In addition, we have to prepare written business plans for technological innovation for the purpose of securing funding from outside"

Similarly, the managing director of a more mature, 12 year-old Korean HTSFs made it apparent that HTSFs have more sophisticated strategic management techniques involving formal strategic review sessions. In such cases, strategic planning occurs on a regular basis reflecting management's perception that formal strategic planning is significant for the benefit of the firm and enhanced performance. The opinion of this managing director is:

> "We have, two to four times a year, a strategy meeting with all branches of the company. Everything is included in the meeting - marketing, R&D, human resources, discussing what course of action we should follow and how we lead the company. The meeting is a very thorough and formal exercise to create corporate strategy throughout various business units..."

Recollecting various internal and external environment conditions surrounding the past technology-sourcing decision was not a problem for decision-makers since innovation projects do not occur very often to them. Above all, they understood well the objective of this study. However, they were highly reluctant to reveal some sensitive information such as estimated budget of the project, R&D investment amount and specification of the project and its result. Thus, these items were dropped. However, the interviewees sympathised with the role of several factors such as estimated appropriation regime, perceived partner trust and perceived legitimacy for technology alliance in their decision-making, the influence of which were predicted in several studies. In short, the pilot study contributed to assure the internal validity of the proposed methods and instruments of this research.

The second phase of the pilot study was pre-testing the questionnaire to rectify any inadequacies and ambiguities of the questions before distributing questionnaires to a large number of respondents. Some wordings were corrected and modified. Overlapping questions were also removed to reduce the size of the questionnaire. In general, the questionnaire was quite straightforwardly designed and structured. One LSE lecturer reviewed the English version of the questionnaire. Two Korean LSE PhD students and one Korean visiting researcher reviewed the Korean version. They found no logical problems or misleading phrases. As a final step, the twenty-one page-questionnaire sets were distributed to two hundred randomly -selected samples from the population, providing each with a self-addressed and stamped return envelope. In a one-month period of time, thirteen responses were received, but their completion rate was poor. Follow-up telephone calls were made but many firms showed disapproval of participating in this research project.

■ Second wave of data collection

Several lessons were learned from the pilot study. First, a student's research projects did not arouse particular interest among the respondents, who consider it to be the kind of market survey that they routinely received. In addition, they did not clearly understand what was being asked and confused the subject with something else. Establishing key respondents was essential because the third or fourth informants had quite limited and narrow knowledge bases with which to answer the questions. These problems had not been apparent from the pilot study because the participants were already committed to the research project and the author was able to clarify the purpose and the questionnaire beforehand; the remaining respondents did not have that opportunity. Second, twenty-one page questionnaire set was still too lengthy. In particular, sending the sets via fax resulted in poor readability, burdening the respondents with taking extra time to look through them carefully. Section 2 caused some problems for respondents to understand the contents and graphic outlay.

Finally, the pilot study revealed that the mail questionnaire survey by the author was extremely cost-inefficient and ineffective. Telephone notification and follow-up letters were essential but they required special skill and costs. Importantly, attractive incentives were required to improve the response rate; the respondents found no merit in revealing their strategic issues. Direct contact with the key informants (i.e., CEO, R&D head or senior managers) was the biggest difficulty to overcome. The questionnaire needed to be redesigned in a more user friendly way. Administering the whole procedure demanded of the researcher tremendous time and costs.

Therefore, this study used a response-inducing strategy by hiring a professional research agency who could manage survey procedure skilfully. Established in 1972, *Lee's PR and Research Ltd.* (www.leespr.co.kr) is the first and the oldest independent marketing research firm in Korea. Headquartered in Seoul, it has nationwide research network in the five major cities in South Korea. Specialised in marketing and social opinion researches and political/presidential election census, it has carried out various research projects on behalf of the government, international academic institutes and major Korean and foreign conglomerates in finance and media industries. The author chose it as an assistant agency because it had in-depth experience and database in surveying HTSFs. For instance, on behalf of the government, it has conducted several investigations into HTSFs' general business environment, technological innovation and their satisfaction with the government assistance programme they receive every two years. Their know-how was enormously helpful in inducing further responses necessary to this study.

Based on a few more pilot pre-tests with Lee's PR assistant team, radical strategic change was made for data collection. Twenty-one pages of questionnaire set were reduced to nine pages by condensing redundant space and adding graphic design aided by sophisticated computerised programmes. The supervisor's signature and evidence of the formal LSE Research Institute sponsorship were added in the introduction section as well as assuring confidentiality for the respondents. Pre-test showed that Section 2, which was found to be tricky and complicated, led many respondents to fail to proceed to the next sections. Thus, Sections 3 and 4, which are key parts of the study, were arranged first. Also, the first section containing the respondent and the firm's general information was moved to the end. Rearrangement of the questionnaire sections enhanced the respondents' understanding of the project at the beginning, convincing them earlier of the genuineness of the questions posed by the researcher. The following table is the structure of the questionnaire in brief.

(Structure of the questionnaire)

Section	**Focus of the question**	
Introduction	Brief introduction of the objective of the research	
Section I	Mode of new technology development project: in-house development vs. external sourcing	The responding firms answered these sections

Section II	Mode of external sourcing (This section is valid only for firms that used external sourcing methods in section II. Firms who used in-house development methods skip this section and go to section IV)	based on the most significant new technology development projects carried out during the last 3 years
Section III	Technological cooperation activities in general	
Section IV	Background of the firm	

According to the *Lee's PR and Research Ltd.*'s previous experience, having a 20-25 per cent response rate is considered quite successful in surveying small and medium firms although it is a much lower response rate than any other type of survey projects which average 30-35 per cent of response rates. Various studies also mention that, on average, 21 % response rate is quite normal when surveying small firms (Dennis Jr. 2003). This manifested the difficulty of empirical study of small firms in general. Given the fact that only one fifth of the population would be likely to respond, care should be taken to secure representative and unbiased responses in order to estimate generalizable population parameters from the sampling. To tackle this problem, several random realistic sampling strategies were made.

First, expecting 20-25 % of response rate on industry average and considering limited time span and budget, our team set a target of collecting around 300 responses (approximately 25 % of response rate) as an adequate sample size for an analysis. This was a realistic approach from the academic point of view as well. For instance, Roscoe (1957) proposes the following rule of thumb for determining sample size:

1. Sample sizes larger than 30 and less than 500 are appropriate for most research.
2. In multivariate research, the sample size should be several times (preferably 10 times or more) as large as the number of variables used in the study.

Second, we adopted proportionate stratified random sampling technique. The proportionate stratified random sampling is that the population is divided into mutually-exclusive subgroups (strata) that are relevant and meaningful in the context of the study. The elements of each subgroup are assumed to be homogenous but comparatively different between groups. The elements of each subgroup have the same probability to be selected based on random sampling procedures, but proportionate to the number of elements in the subgroup (stratum). That is, members represented in the sample from each subgroup (stratum) will be proportionate to the total number of elements in the respective subgroups. Such sampling design is illustrated in the following table.

(Table 36) Proportionate stratified random sampling

Sub industry sector	**Actual number of firms in the population**	**Targeted collection number of responding firms in the population (approx)**
Telecommunication equipment manufacturing	312 (26.9%)	81 (26.9%)
Industry communication equipment manufacturing	186 (16.0%)	48 (16.0%)
Communication related household electrical appliances	53 (4.6%)	14 (4.6%)
Internet/solutions	188 (16.2%)	49 (16.2 %)
Software/Hardware	206 (17.8%)	53 (17.8 %)
Semiconductor/accessories (parts)/material	90 (7.8 %)	23 (7.8 %)
ETC.	125 (10.8%)	32 (10.8%)
Total	**1,160**	**300 (approx)**

Sub-industry sectors were used as subgroup divisions because, as industry experts state, technology strategy is assumed to differ between sub-industry groups with a similar background, rather than firm size or age. Stratified random sampling is important because occasionally a simple random sample yields a disproportionate number of responses from one group or another, whereby the representativeness of the sample could be highly skewed and bias (Zikmund 1991).

Five professionally-trained and experienced interviewers identified and contacted the first and second informants (CEO, senior manager or R&D head). They explained to them the purpose of the research project and asked for their participation in the survey. The research firm was already well known to many HTSFs who previously participated in the firm's project. Thus, many of them had some confidence in the research project. monetary incentives equivalent of £5.00 GBP (in the form of multi-travel cards) were offered, conditional on responding to the questionnaire. In addition, various prizes including an over-night vocational package to Jeju Island (a southern resort island in South Korea) were offered to three selected respondents determined by randomly selected respondents drawn from a lottery. Rather than using mail or fax, our team had developed an on-line survey method. Upon receiving the questionnaire via e-mail, they were able to answer it and send back their answers immediately, with no chance of missing the delivery. This also proved efficient when the interviewers needed to request further information for filling in the missing data. For those who are not competent at Internet use, or have improper e-mail addresses, ordinary mail was used. The first questionnaire distribution was made to the key informants after contacting them through telephone. Follow-up calls were made for those who did not respond or were sluggish respondents. The data collection procedure was conducted from 23.12. 2002 to 4.3. 2003.

In total, 288 firms had replied by mid-march 2003. Non-responding firms included:

- Firms with incorrect e-mail address and postal addresses
- Firms with no specific technology development or non-substantial R&D projects during the past three years. (During the financial crisis in 1997-1999, many small and medium firms halted new technology development temporarily)
- Top-level managers on business trips with no substitute persons available;
- Companies whose regulations prohibited them from revealing information necessary for this study.

Interviewers requested further data on the missing and incomplete items from the responding firms in question. However, 30 firms, completing questionnaires with less than 50 per cent, refused to provide further information. Thus, they were excluded from the final analysis. However, at least for the questions essential to the major hypotheses tested, the received questionnaires exhibited a 100 % completion rate, so further attempts to complete information were not made. The e-survey was a convenient time-saving mechanism for receiving feedback and further information. 258 firms were finally used for the analysis.

The response rate was 22.2 %. It was slightly less than we expected, but still satisfactory. The following is the composition of the responding firms.

(Table 37) Structure of the responding firms

Industry type	**Actual number of responding sample firms**	**Targeted number of responding firms in the population (approx)**	**Total number of firms in the population**
Telecommunication equipment	**65 (25.2%)**	81 (26.9%)	312 (26.9%)

manufacturing			
Industry communication equipment manufacturing	**36 (14.0%)**	48 (16.0%)	186 (16.0%)
Communication related household electrical appliances	**14 (5.4%)**	14 (4.6%)	53 (4.6%)
Internet/solutions	**48 (18.6%)**	49 (16.2 %)	188 (16.2%)
Software/Hardware	**48 (18.6%)**	53 (17.8 %)	206 (17.8%)
Semiconductor/accessories (parts)/material	**27 (10.5%)**	23 (7.8 %)	90 (7.8 %)
ETC.	**20 (7.8 %)**	32 (10.8%)	125 (10.8%)
Total	**258**	**300 (approx)**	**1,160**

The composition of the responding firms did not exactly match our target, but both compositions were almost alike, indicating that the responding firms were representative of the population. Three checks for non-response bias were conducted. First, the mean difference between respondents and non-respondents with respect to the number of employees, length of operations (age), sales and net profit was tested using an unpaired T-test. The result demonstrated that all t-statistics were insignificant at the 5% of significance. Second, since surveys arrived over a period of almost twelve weeks, one could argue that late respondents more closely resembled non-respondents, in which case, if a response bias exists, late respondents would differ from early respondents. Accordingly, respondents were grouped by arrival date and the dependent variables were compared using one-way Analysis of Variance. No significant differences were observed. Finally, respondents had the option of identifying themselves and, to the extent that anonymous respondents more closely resemble non-respondents, if a response bias exists, anonymous respondents would differ from respondents that disclosed their identity. No statistical differences between anonymous and identified respondents were obtained. These analyses, although not direct tests for response bias, raise confidence that response bias is not a critical issue in the present study. PC software programmes such as SPSS 11.0, SAS and EXCEL were used for the descriptive and analytical analysis. Data encoding was assisted by the research agency. An LSE lecturer from the Statistics department also advised and examined the statistical analysis.

7.3 Descriptive analysis of the survey result

The aim of this section is to describe the respondents and summarise the descriptive analysis (minimum and maximum score, mean, standard deviation and variance) of variously-measured variables obtained from the survey. Variables are selected from basic and fundamental issues that characterise the responding firms and that the researcher is interested in. These include the basic features of the respondents such as age, business area, size in terms of employee numbers, sales and type of the firm, and the number of R&D workers and intellectual capital. In particular, this study is interested in how the respondents have carried out the technology projects in terms of their frequency and methods and, in doing so, the role of formal and informal technological cooperation.

This section helps the researcher to understand the data by demonstrating how well the question items and measurements are framed, and providing glimpses of the magnitude of the technology alliance by the respondents and its utility.

■ Characteristics of the responding firms

The following is the number of responding firms and their major business areas.

■ Major Business Area of the responding firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Telecommunication equipment manufacturing	65	25.2	25.2	25.2
	Industry communication equipment manufacturing	36	14.0	14.0	39.1
	Communication related household electrical appliances	14	5.4	5.4	44.6
	Internet/solutions	48	18.6	18.6	63.2
	Software/Hardware	48	18.6	18.6	81.8
	Semiconductor/accessories (parts)/material	27	10.5	10.5	92.2
	ETC.	20	7.8	7.8	100.0
	Total	258	100.0	100.0	

The firms in the telecommunications equipment manufacturing sector account for the largest proportion of the respondents (25.2 % of the total) followed by those in the internet/solution and software/hardware sectors. Altogether they account for 62.4 % of total respondents.

■ Size of the responding firms (in sales) (2001)

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	250,000-500,000 pounds	58	22.5	22.5	22.5
	500,001-2,500,000 pounds	91	35.3	35.3	57.8
	2,500,001-5,000,000 pounds	43	16.7	16.7	74.4
	5,000,001-10,000,000 pounds	28	10.9	10.9	85.3
	10,000,001-40,000,000 pounds	38	14.7	14.7	100.0
	Total	258	100.0	100.0	

Many respondents did not want to express sales size in exact numbers, but in approximation. The above table shows that more than 57.8 % of the respondents had less than £2,500,000 of sales in year 2001 (combining firms with £250,000- £500,000 of annual sales and those with £500,001-£2,500,000). This 14.7 % of respondents are relatively large, having from £10,000,001 to £40,000,000 of annual sales. The sale size of the firm tends to be widely dispersed across the sample firms.

■ **Respondents' number of employees**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10-20	84	32.6	32.6	32.6
	21-50	85	32.9	32.9	65.5
	51-100	49	19.0	19.0	84.5
	101-200	23	8.9	8.9	93.4
	201-300	8	3.1	3.1	96.5
	301-400	9	3.5	3.5	100.0
	Total	258	100.0	100.0	

Descriptive statistics of number of employees of the respondents

	N	Minimum	Maximum	Mean	Std. D
Number of employees	258	10	400	62.38	76.662
Valid N (listwise)	258				

The smallest number of employees is 10, and the largest 400. 65.5 % of the respondents have less than 50 employees, while 3.5 % of them have a relatively large number of employees, more than 300. On average, the respondents have total 62.38 employees. But, the value of the standard deviation (76.662) indicates that employee numbers are widely dispersed from small to large totals.

■ **The respondents' number of R&D workers**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than 5	34	13.2	13.2	13.2
	5-10	125	48.4	48.4	61.6
	11-15	40	15.5	15.5	77.1

16-20	26	10.1	10.1	87.2
21-30	14	5.4	5.4	92.6
over 31	19	7.4	7.4	100.0
Total	258	100.0	100.0	

Descriptive Statistics of number of the respondents' R&D workers

	N	Minimum	Maximum	Mean	Std. D	Variance
Number of R&D workforce	258	1	180	13.52	16.675	278.064
Valid N (listwise)	258					

Almost half (48.4 %) of the responding firms, as seen above, have between 5 and 10 R&D workers. This is quite a typical number of R&D workers among Korean HTSFs. The smallest number of R&D worker is 1 while the largest number is 180. On average, the respondents hire 13.52 R&D workers out of 62.38 total employees, accounting for 22 % of total employees with 16.675 standard deviation.

■ Number of employees * the number of R&D workforces (Cross-tabulation)

			Number of R&D workforce						Total
			less than 5	5-10	11-15	16-20	21-30	over 31	
Employee	10-20	Count	25	50	8	1	0	0	84
		% within Employee	29.8%	59.5%	9.5%	1.2%	.0%	.0%	100.0 %
	21-50	Count	7	40	22	12	2	2	85
		% within Employee	8.2%	47.1%	25.9%	14.1%	2.4%	2.4%	100.0 %
	51-100	Count	2	19	7	7	8	6	49
		% within Employee	4.1%	38.8%	14.3%	14.3%	16.3%	12.2%	100.0 %
	101-200	Count	0	10	2	6	2	3	23
		% within Employee	.0%	43.5%	8.7%	26.1%	8.7%	13.0%	100.0 %
	201-300	Count	0	3	1	0	0	4	8
		% within Employee	.0%	37.5%	12.5%	.0%	.0%	50.0%	100.0 %
	301-400	Count	0	3	0	0	2	4	9
		% within Employee	.0%	33.3%	.0%	.0%	22.2%	44.4%	100.0 %
Total		Count	34	125	40	26	14	19	258
		% within Employee	13.2%	48.4%	15.5%	10.1%	5.4%	7.4%	100.0 %

This study investigated whether there was a correlation between the respondents' numbers of R&D workers and total employees, for instance, that smaller firms tend to have more R&D workers than larger firms. That assumption is based on the fact that a feature of high-tech industry is that smaller R&D-intensive firms tend to have relatively larger numbers of R&D workforces than the larger firms, in order to specialise in R&D. Each cell in the above cross-tabulation shows the number of R&D workforces given the number of total employees and its percentage. However, the table cannot clearly delineate any noticeable association of the two variables, although we can see a glimpse of a pattern, namely that firms with more employees tend to have more R&D workers.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	128.263(a)	25	.000
Likelihood Ratio	120.767	25	.000
Linear-by-Linear Association	69.938	1	.000
N of Valid Cases	258		

a 22 cells (61.1%) have expected count less than 5. The minimum expected count is .43.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.705	.000
	Cramer's V	.315	.000
N of Valid Cases		258	

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

The Chi-square test was used to measure the association between the two variables and its statistical significance more clearly. It shows that its value is 128.263 which is larger than 37.652 with df=25 at α=0.05. We can reject the null hypothesis that 'there is no relationship between firm's employees and the firm's with R&D workers', with 95 per cent of confidence. Contrary to the study's assumption, larger respondents tend to have larger R&D workers and this observation is significant. However, the degree of their association (i.e., Cramer's V) is 0.315 which is rather moderate.

Descriptive Statistics of the respondent's total number of intellectual capital

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
total	204	1	398	15.06	42.060	1769.035
Valid N (listwise)	204					

The responding firms have varying numbers of intellectual capitals from 1 to 398. On average, responding firms possess 15.06 intellectual capitals. However, this figure does not help to estimate the number of intellectual capitals that each individual firm may possess as the figure is widely dispersed among firms (standard deviation is 42.060). So, we have to rely on the following table to estimate it.

■ **Total number of intellectual capital of the respondents**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	108	41.9	41.9	41.9
	6-10	38	14.7	14.7	56.6
	11-20	28	10.9	10.9	67.4
	21-30	14	5.4	5.4	72.9
	31-40	3	1.2	1.2	74.0
	41-	13	5.0	5.0	79.1
	no comment	54	20.9	20.9	100.0
	Total	258	100.0	100.0	

41.9 % of the responding firms possess less than 6 intellectual capitals in the form of patent, trade secret and utility mark. 14.7 % of the responding firms possess 6-10 intellectual capitals. Both groups together account for 56.6 % of total responding firms; more than half of the respondents possess less than 10 intellectual capitals. However, 54 responding firms did not inform us of the number of intellectual capitals they possess. They refused to reveal this because some feel that specifying the exact number would be a rather sensitive issue. Some fail to remember the exact number because they have too many or they feel embarrassed when they have relatively little. Unfortunately, this study couldn't specify them from the company reports or any other secondary resources.

Total number of intellectual capital * number of R&D workforce (Cross-tabulation)

			The number of R&D workforce						Total
			less than 5	5-10	11-15	16-20	21-30	over 31	
Total number of intellectual capital	1-5	Count	16	57	19	9	2	5	108
			14.8%	52.8%	17.6%	8.3%	1.9%	4.6%	100.0%
	6-10	Count	4	23	4	3	2	2	38
			10.5%	60.5%	10.5%	7.9%	5.3%	5.3%	100.0%
	11-20	Count	1	10	4	7	3	3	28
			3.6%	35.7%	14.3%	25.0%	10.7%	10.7%	100.0%

	21-30	Count	1	8	2	1	1	1	14
			7.1%	57.1%	14.3%	7.1%	7.1%	7.1%	100.0%
	31-40	Count	0	1	0	0	1	1	3
			.0%	33.3%	.0%	.0%	33.3%	33.3%	100.0%
	41-	Count	2	3	1	1	3	3	13
			15.4%	23.1%	7.7%	7.7%	23.1%	23.1%	100.0%
	no comment	Count	10	23	10	5	2	4	54
			18.5%	42.6%	18.5%	9.3%	3.7%	7.4%	100.0%
Total		Count	34	125	40	26	14	19	258
			13.2%	48.4%	15.5%	10.1%	5.4%	7.4%	100.0%

This study investigated whether the number of R&D workers and the number of intellectual capitals the firm possesses are highly related; the efficiency of innovation may or may not be related to the number of the R&D workers. The above table does not clearly depict the relationship between the two variables; 1-5 intellectual capitals is the number most often possessed by firms with all ranges of R&D worker numbers.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.805(a)	30	.050
Likelihood Ratio	36.697	30	.186
Linear-by-Linear Association	2.871	1	.090
N of Valid Cases	258		

a 26 cells (61.9%) have expected count less than 5. The minimum expected count is .16.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.412	.050
	Cramer's V	.184	.050
N of Valid Cases		258	

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

To measure the relationship between the two variables and its significance, Chi-square test was used. Its value is 43.805 which is barely larger than the critical value of 43.773 with df=30 at α=0.05. This indicates that we can reject the null hypothesis that there is no relationship between the two, with 95 % of the confidence level. As the number of R&D workers of a firm increases, the number of intellectual capitals is likely to increase as well. However, the p-value is almost equal to α=0.05 and the degree of association (Crammer's V) is only 0.184. In addition, 54 firms did not reveal their total number of intellectual capitals. Thus, although we may conclude that there is a very weak relationship between the two variables, the actual existence of such a relationship and its degree of association is elusive demanding further study to investigate the efficiency of innovation.

■ The age of the responding firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-5 year	102	39.5	39.5	39.5
	6-10	84	32.6	32.6	72.1
	11-15	22	8.5	8.5	80.6
	16-20	20	7.8	7.8	88.4
	over 20	30	11.6	11.6	100.0
	Total	258	100.0	100.0	

30 firms (11.6 %) have more than 20 years of business experience since their establishment. However, 72.1 % of the responding firms were established not more than 10 years ago, showing that the dominant responding firms are very nascent. 39.5 % of respondents were established less than 5 years before. In addition, the fact that Korean HTSFs are very young is well exhibited in this result.

■ Type of the responding firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	listed	140	54.3	54.3	54.3
	non-listed	118	45.7	45.7	100.0
	Total	258	100.0	100.0	

This study investigated whether the respondents are listed on the KOSDAQ stock market or not. Since 1996 when the KOSDAQ stock market was launched, many promising and well-known HTSFs attempted to register on the stock market. The registered ones were considered technology leaders in their relevant markets and received various financial benefits from capital markets and government. The responding firms are almost split into half between listed and non-listed firms; 54.3 % of those are listed firms while 45.7 % are non-listed firms.

Firm type * Total number of intellectual capital (cross-tabulation)

			Total number of intellectual capital							Total
			1-5	6-10	11-20	21-30	31-40	41-	no comment	
Firm type	listed	Count	54	21	13	9	3	4	36	140
			38.6%	15.0%	9.3%	6.4%	2.1%	2.9%	25.7%	100.0%
	non-listed	Count	54	17	15	5	0	9	18	118
			45.8%	14.4%	12.7%	4.2%	.0%	7.6%	15.3%	100.0%
Total		Count	108	38	28	14	3	13	54	258
			41.9%	14.7%	10.9%	5.4%	1.2%	5.0%	20.9%	100.0%

This study concerned whether stock market (KOSDAQ)-listed firms have more intellectual capitals than non-listed firms, as the former is believed to be more technologically competitive and capable. The table above shows that 38.6 % and 45.8 % of listed and non-listed firms respectively have 1-5 intellectual capitals and 21.1 % and 17 % of two groups have 6-10 intellectual capitals respectively. The number of both listed and non-listed firms decreases as the number of total intellectual capitals increases, but it appears that non-listed firms do not particularly deceases their numbers at a faster rate.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.833(a)	6	.094
Likelihood Ratio	12.094	6	.060
Linear-by-Linear Association	2.548	1	.110
N of Valid Cases	258		

a 2 cells (14.3%) have expected count less than 5. The minimum expected count is 1.37.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.205	.094
	Cramer's V	.205	.094
N of Valid Cases		258	

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

To measure the association between the two variables and its significance, the Chi-square test was used. The chi-square value is 10.833, which is smaller than 12.592 with df=6 at α=0.05. Thus, we fail to reject the null hypothetical assumption with 95 % of confidence that the two variables are not associated. However, this result may be unreliable as 25.7 % of the listed firms and 15.3 % of the non-listed firms do not specify the number of intellectual capitals they own.

In summary, this study found that the respondents are relatively young with around 10 years or fewer years of business experience. On average, they are hiring 62.38 employees, among which 13.52 (22 %) are the R&D workers, and possess 15.06 intellectual capitals. The respondents are a mixture of listed and non-listed firms and are not significantly different in terms of applying for or possessing patents to protect their knowledge assets from the market.

So far, this study has summarized the characteristics of the Korean HTSFs found from the questionnaire survey. Specifically, we have investigated the frequency distribution and central tendency of the various aspects of the respondent firms. Descriptive data analysis shows that the respondents are widely dispersed upon the measured items and its measured scale; they are not adhering to only a certain point of scale and items across industry type, firm size, age, number of R&D workers and the number of intellectual capitals. This reflects that the respondents are widely varied in their background. The data collected from them is highly likely to be representative of the population.

■ Technology innovation activities of the responding firms

This section summarises the general technology innovation activities of the respondents and descriptive analysis of the several issues that are related to such activities including innovation types, methods and technological cooperation. In this section, the number of the technology/product developments, rather than the individual firms themselves, is the unit of the analysis.

■ **Descriptive statistics of total number of new technology/product developed during the past 5 year**

	N	Range	Minimum	Maximum	Sum	Mean	Std. D	Variance
Total number of new technology/product developed	258	374	1	375	2876	11.15	26.347	694.181
Valid N (listwise)	258							

This study probed how many technologies/products that the responding firms have developed during the past 5 years (1998-2003). It intended to find out how these firms are actively involved in their technology innovation efforts. The number does not necessarily coincide with the number of the firm's intellectual capitals because newly-developed products/technology may not be registered in the patent office. In total, 258 respondents developed 2,876 cases of technology/products. On average, each responding firm developed 11.15 cases of technology/product during the past five years. However, the table above demonstrates that the centrality of the average number is widely dispersed, as seen in the value of range (1 to 375), standard deviation (26.347) and variance (694.181).

■ **T-test on the relationship between the numbers of the technology/product developed and the type of the firm**

This study examined whether the degree of technology innovation activities (in terms of its absolute number of frequency) may differ between listed and non-listed firms, testing whether the listed firms are involved in more technology innovation activities than non-listed firms.

Group Statistics

	Firm type	N	Mean	Std. Deviation	Std. Error Mean
Total number of technology/product developed	listed	140	10.13	14.018	1.185
	non-listed	118	12.36	35.898	3.305

		Levene's Test for Equality of Variances		t-test for Equality of Means						
Number of technology/product developed		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error	95% Confidence	
									Lower	Upper
	Equal variances assumed	1.351	.246	-.676	256	.500	-2.23	3.296	-8.718	4.264
	Equal variances not assumed			-.634	146.966	.527	-2.23	3.511	-9.165	4.710

The above table shows that listed firms have developed an average of 10.13 cases of technology/products while the non-listed firms have 12.36 cases during the past five years. The listed firms have even fewer less number of technology/product developed. The T-test examines whether the mean difference of this average number between the two groups is statistically significant. The Z-score (obtained) is –0.634. the Z-score (critical) is ± 1.965 at α=0.05 with 2-tails. The obtained Z-score (-0.634) is larger than the critical Z-score (-1.965), indicating that we fail to reject the null hypothesis that 'there is no mean difference between the two groups' with 95 per cent confidence level. Simply, we can see that the p-value (0.527) is much larger than the α=0.05, supporting that the average number of technology/product developments is not different between the two groups (listed vs. non-listed firms).

■ Descriptive statistics of the types of technology/product development

	N	Range	Minimum	Maximum	Sum	Mean	Std. D	Variance
Imitating foreign product/technology	84	19	1	20	241 (8.7%)	2.87	3.196	10.212
Improving foreign product/technology	65	19	1	20	197 (7.1%)	3.03	3.147	9.905
Improving the firm's existing product/technology	157	359	1	360	1,043 (37.8%)	6.64	29.386	863.539
Develop new product/technology independently	229	39	1	40	1,023 (37.1%)	4.47	5.182	26.855
Etc.	31	99	1	100	254 (9.2%)	8.19	19.253	370.695
Valid N (listwise)	7				2,876 (100%)			

This study investigated the types of development that are related to technology/product development activities. Out of a total of 2,876 cases of technology/product development, 241 cases were about imitating foreign product/technology (8.7%); 197 cases were about improving foreign product/technology (7.1%); 1,043 cases were about improving the firm's existing product/technology (37.8%); 1,023 cases were about developing new product/technology independently (37.1%); and 254 cases were about other issues (9.2%).

These figures are equivalent to saying that, out of 11.15 cases of technology/product development by the individual firm during the past five years; 0.97 cases were about imitating foreign product/technology; 0.79 cases were about improving foreign product/technology; 4.21 cases were about improving the firm's existing product/technology; 4.13 cases were about developing new product/technology independently and 1.03 cases were about other issues. The fact that imitating and improving other firm's technology accounts for only 15.8 % of the total number of the technology/product development, reveals the strong efforts of the respondents to improve the firm's independent innovation capability by improving and developing new product/technology.

■ Technological cooperation activities of the responding firms

This section describes the technological cooperation activities of the Korean HTSFs revealed by the survey. Based on Korean literature and discussion with industry experts, this study enumerates 4 major types of equity alliance, 14 major types of non-equity alliance and 11 major types of informal technology cooperation that are most often referred and employed by Korean HTSFs. Using the mode of the technology cooperation (formal and informal) as the unit of analysis, this section will investigate the extent of using various cooperation modes among the responding firms. Second, using the firm as a unit of analysis, this study will investigate how the responding firms evaluate the impact of their technology cooperation activities on their firms in enhancing technological capability.

■ Total number of equity alliance by responding firms during the past 5 year

	Number of responding firm	Distribution (%)	Average
Joint venture with foreign firm	12 firms	17 cases (13.7%)	1.42 cases
Joint venture with domestic firm	17 firms	30 cases (24.2 %)	1.76 cases
Minority equity investment	32 firms	68 cases (54.8%)	2.13 cases
etc.	5 firms	9 cases (7.3 %)	1.8 cases
Total	**53 firms**	**124 cases (100%)**	**2.33 cases/per firm**

According to the table, 12 firms have been involved in 17 cases of joint venture with foreign partners, 17 firms with domestic partners. On the other hand, 32 firms have been involved in 68 cases of minority equity investment and 5 firms have been involved in 9 other cases. (including acquisitions or joint research cooperation). Joint venture with domestic firms is almost twice as frequent as that with foreign firms. Minority equity investment is the most often-adopted equity-based technology alliance. Some firms have been involved in these modes simultaneously, therefore resulting in an overlapping of the total number of respondents. Excluding the double counting, a total of 53 firms among 258 (21 % of total) firms are said to be involved in 124 cases of various modes of equity alliance. On average, each responding firm has been involved in 2.33 cases of equity alliance during the past 5 years.

Only 21 % of the respondents have experienced equity alliance at least once during that period. The study assumes that the respondents perceive equity-sharing interfirm linkage would be too costly to carry out the technology/product development due to the risk of sharing proprietary know-how, the desire for control by individual partners, coordination of different time horizon and disagreement of design specification. In addition, small firms tend to have relatively short time-spans and limited financial budgets for technology development projects. Equity-based technology alliance is not appropriate and efficient, as it tends to require long-term commitment. Narula (2001) and Hagedoorn (1990) find that, amid a growing number of interfirm technology cooperative efforts, the number of equity technology alliances is rather decreasing in the R&D-related global high-tech industries due to its inefficiency, fewer incentives and higher failure rate. The same logic can be applied to the Korean telecommunications industry.

■ Total number of non-equity alliance by responding firms during the past 5 year

		Number of responding firms	Distribution (%)	Average
Licensing	Licensing from domestic firm	24	70 (6.2%)	2.96 cases
	Licensing from foreign firm	35	82 (7.2%)	2.34 cases
Co-production	Co-production with domestic competitor	49	156 (13.7%)	3.18 cases
	Co-production with foreign competitor	9	14 (1.3%)	1.67 cases
Research pact	Research pact with domestic competitor	34	108 (9.5%)	3.18 cases
	Research pact with foreign competitor	7	7 (0.7%)	1.14 cases
	Research pact with research institute	18	31 (2.8%)	1.78 cases
	Research pact with university	36	58 (5.1%)	1.61 cases
Joint developm-ent	Joint development agreement with domestic customer	46	231 (20.3%)	5.02 cases

	Joint development agreement with foreign customer	8	13 (1.2%)	1.75 cases
R&D contract	R&D contract with research institute	45	143 (13%)	3.18 cases
	R&D contract with university	58	127 (11.2%)	2.21 cases
Technology transfer from research institute/university		23	52 (4.6%)	2.26 cases
etc.		12	41 (3.6%)	3.42 cases
Total		**169 firms**	**1,139 cases (100%)**	**6.74 cases/ per firm**

Various literature has shown that non-equity alliance is more useful than equity alliance in R&D related activities due to its flexibility and lower set-up costs. The data here clearly supports the argument. 169 firms (66 %) out of a total of 258 respondents have been involved in non-equity alliance at least once during the past five years, totalling 1,139 cases altogether. This can be likened to the statement that each individual firm of the 169 respondents has been involved in 6.74 cases of non-equity alliance during the same period. 91 firms (35 %) out of a total of 258 respondents have not been involved in any formal alliance relationship either through equity or non-equity alliance. On average, licensing is most often used as a non-equity alliance mode, followed by R&D contract, research pact, co-production, joint development and technology transfer. Domestic customers and competitors are preferred as major non-equity alliance partners over foreign ones, accounting for about 50 % of total partner type. Also partners with research institutes and universities have established significant alliance partnership with Korean HTSFs, accounting for 40 % of total non-equity alliance partners.

The total number of non-equity alliance is about nine times more than that of the equity alliance, and three times more responding firms have experienced non-equity alliance.

Unlike equity alliance requiring considerable resources to maintain collaborative activity, non-equity alliance is getting cheaper to undertake and more solid in the value-adding process such as technological innovation, although it is a less far-reaching, not too mandatory commitment. Because of the improvement in communications, and ease of enforceability of contracts, small firms are getting less interested in forming equity alliance (Narula 2004). In addition, it is probable that many small firms decide to experiment first with non-equity alliance before taking an equity ownership position with the partner, if technology cooperation is necessary and inevitable.

■ Total number of informal relationships for technology development during the past 5 years

Compared to the formal technology cooperation (equity and non-equity alliance), informal technology cooperation is much more frequently and widely used on an irregular basis. All 258 responding firms without exception have been actively involved in various forms of informal technological cooperations with the government body or customers/competitors. The following table summarises how often the responding firms have used 11 different types of informal cooperative relationship for technology development during the past five years.

	1- 2	3-5	6-10	11-20	More than 20	N
P3q4_1	165	55	22	7	9	258
P3q4_2	190	28	25	9	6	258
P3q4_3	202	39	11	3	3	258
P3q4_4	176	61	17	3	1	258
P3q4_5	180	54	14	4	6	258
P3q4_6	156	58	30	5	9	258
P3q4_7	163	49	25	11	10	258
P3q4_8	112	53	41	20	32	258
P3q4_9	110	63	52	16	17	258
P3q4_10	146	56	28	10	18	258
P3q4_11	245	4	4	4	1	258
Total	1,844	520	269	92	112	**2,838**

P3q4_1: Governmental body's technical information support
P3q4_2: Governmental body's technical facilities lending support
P3q4_3: Governmental body's technical expert support
P3q4_4: Governmental body's patent registration support
P3q4_5: Governmental body's human resource education support

P3q4_6: Technical advice from domestic supplier
P3q4_7: Technical advice from foreign supplier
P3q4_8: Technical information exchange with customers
P3q4_9: Technical information exchange with domestic competitors
P3q4_10: Technical information exchange with foreign competitors
P3q4_11: etc. (i.e., information exchange with consulting firms, industry associations and technical information centre or by attending seminar or road show)

It shows that p3q4_11 (etc.) is most often used by the 245 responding firms, using it '1 to 2 times' during the past five years. That is because this item includes all other possible informal relationships that are not included in the list. Apart from that, the responding firms have used remaining 10 types of informal cooperation almost evenly, by using them at least 'less than 2 times' during the same period. There have been a total of 2,838 cases of informal relationships by the frequency categories, among which 65 % of them is "1 to 2 times". That means that at least 65 per cent of the respondents have utilized informal relationships with various partners once or twice during the past five years. The informal relationship partner largely consists of two groups: customer/competitor and government body. We can see that informal relationships with customers and domestic/foreign competitors are much more frequent than that with governmental body when we look at larger frequency categories, for instance, frequency category "11-20" and "more than 20". Certainly the chance for informal relations is higher with customer and competitor, as interaction with them is more frequent than any other.

As many studies predicted (Lee 1995; Rothwell & Dodgson 1991), this study also found that Korean HTSFs rely heavily on the informal linkage with external agencies to complement their technical knowledge. Informal cooperation is the result of various personalised interactions of the firm with various entities (i.e., visiting government support centres, attending seminars and, mostly, informal chatting with customers and competitors) driven by accidental opportunities rather than purposeful intentions and organisational strategies (Kreiner & Schultz 1993). Personalised interaction with such entities provides an excellent opportunity for sharing community gossip, scientific knowledge, visions and work plans.

However, the ideas and knowledge inspired by informal relationship tend to be loose, which take a long time to become established and sellable truth. Thus, the immediate value of the information being shared through the informal linkage is low and small unless the linkage is developed into a more formal and structured relationship.

Nevertheless, the vivid formation of informal relationships by the respondents found in this study allows several implications. The commercial future of the HTSFs depends very much on their ability to embody new knowledge in products; the earlier and the more privileged (patent rights), the better. The intense time competition in new product development makes every Korean HTSF extremely dependent on access to the current stream of information. Traditional sources of information such as literature, journals, etc. are important, but, relative to the speed of development, they seldom carry current information, but rather older data, which may no longer be of great value. In this sense, informal collaboration is a window through which the frontier is recognised and a window that ignites a whole new process of technology development without the formality of contract. However, disappointing results are also repeatedly reported due to institutional differences between industry, academia and organisation (Kreiner & Schultz 1993).

Unfortunately, compared to formal relations such as strategic alliance, informal relations have been underrepresented in management studies; it is a new and emerging field. As an initial step for further research, it is necessary to collect a number of success-case stories, so, that we can document how such informal collaboration has emerged and formed over time. Based on this, several themes can be addressed. For instance, excitement, commitment and other sentiments may be more important for the establishment and success of informal collaboration than the benefit-cost calculation. To the practitioner, such a relationship will never occur and be maintained without a high-level of mutual trust and the significant role of management. To policy-makers, it is essential to establish cost-free technological infrastructure combining domestic R&D institutes/universities and government-sponsored information centres. Strengthening the function of such technological infrastructure will encourage HTSFs to further utilise and exchange valuable information necessary to the technology innovation.

■ The overall impact of technology cooperation activity on the responding firms

The fundamental question in this section is to ascertain to what extent overall technological cooperation activities have contributed to the Korean HTSFs in general. To this end, this study measures the perceived impact of the overall technological cooperation activities on the respondents in terms of enhancement of their innovation capability.

	Items	Strongly disagree			Neutral			Strongly agree
Q1	Technology choice capability has been improved	1	2	3	4	5	6	7
Q2	Modification capability of existing technology has been improved	1	2	3	4	5	6	7
Q3	R&D, design and innovation capability have been improved	1	2	3	4	5	6	7
Q4	Commercialisation and manufacturing capability have been improved	1	2	3	4	5	6	7
Q5	Absorptive and learning capability has been improved	1	2	3	4	5	6	7

Q6	Overall technological capability has been improved	1	2	3	4	5	6	7

The above items include six major areas that a firm should build through innovation efforts. The respondents are asked to evaluate the effect of their various formal and informal collaboration on the above six items by indicating the extent of their contributions. Using the interval scale (7-point Likert scale), 1 indicates 'strongly disagree' with the statement, 4 indicates 'neutral' and 7 indicates 'strongly agree' with the statement. As the higher the marked figure, the higher the respondents perceive that their overall technological cooperation activities improved their firm's innovative capability. 8 firms refused to answer this question, thus, only 250 firms were used for a descriptive analysis.

Goodness of measure (reliability and validity test)

Before analysing the impact of the technological cooperation on the innovation capability of the responding firms, it is important to make sure that the instrument that this study develops to measure the concept (innovation capability) is indeed accurately measuring the concept (*reliability*). At the same time, it is necessary to ensure that the instrument (all items) is actually measuring the same concept that the study set out to measure (*validity*)[11]. Testing the goodness of measurement ensures the rigorousness of the measurement and findings of the study. Cronbach's alpha is used to test the reliability of the instrument[12]. Nunally (1978) suggests that a Cronbach's alpha between 0.5-0.6 is quite sufficient in social science research study. Sekaran (2000) suggests that, in general, reliability less than 0.6 Cronbach's alpha is considered to be poor, those in the 0.7 range acceptable and those over 0.8 good. This study will consider the coefficient of the Cronbach's alpha larger than 0.6 as reliable and internally consistent.

```
Reliability Coefficients     6 items

Alpha =   .9614              Standardized item alpha =   .9614
```

The result above indicates that the Cronbach's alpha for the six items

[11] Simply put, the reliability test means how consistently a measuring instrument measures the concept under examination, and the validity test means how well an instrument that is developed measures the particular concepts it is supposed to measure (Sekaran 2000)

[12] Cronbach's alpha is a reliability coefficient that indicates how well the items in a set are positively correlated to one another. It is computed in terms of the average inter-correlations among the items measuring the concept. The close the alpha is to 1, the higher the internal consistency reliability.

measured is 0.96. The internal consistency reliability of the measures used in this study can be considered very good.

Factor analysis was used to test the validity of the instrument. It will examine whether the six variables suggested are correlated and representative as a group of one distinct concept: innovation capability of a firm. Principle component analysis is used because the objective is to summarise most of the original information (variance) in a minimum number of factors. Varimax rotation is applied. The following is the result of the analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.169	86.153	86.153	5.169	86.153	86.153
2	.258	4.295	90.448			
3	.221	3.678	94.126			
4	.156	2.599	96.725			
5	.111	1.857	98.582			
6	.085	1.418	100.000			

Extraction Method: Principal Component Analysis.

Only the factors having eigenvalues greater than 1 are considered significant. Accoding to the above table, only one factor (component) has eigenvalue greater than 1 (5.169), indicating that six different variables as a set of measurement accurately represents only one concept of interest, the innovation capability of a firm. 86.153 (cumulative %) indicates that the factor 1 (component 1) can explains 86.153 % of the variation of the six variables. This is quite a strong explanatory power of the factor 1. In summary, the key concept (innovative capability of a firm) is tapped by six measurement items correctly and the validity of the measurement is very good.

Descriptive analysis of the impact of technology cooperation activity on innovation capability

The following is the result of the measurement of each item by the respondents.

Frequency of responding firms on the overall impact of their technology cooperation activity

Question items	Strongly disgree (%)	Dis Agree (%)	Somewhat disagree (%)	Neutral (%)	Somewhat agree (%)	Agree (%)	Strongly agree (%)	Total
P3q5_1	44 (17.6)	23 (9.2)	15 (6.0)	58 (23.2)	77 (30.8)	19 (7.6)	14 (5.6)	250
P3q5_2	55	17	20	59	63	29	7	250

	(22.0)	(6.8)	(8.0)	(23.6)	(25.2)	(11.6)	(2.8)	
P3q5_3	49	24	25	49	69	27	7	250
	(19.6)	(9.6)	(10.0)	(19.6)	(27.6)	(10.8)	(2.8)	
P3q5_4	53	17	23	60	63	26	8	250
	(21.2)	(6.8)	(9.2)	(24.0)	(25.2)	(10.4)	(3.2)	
P3q5_5	44	9	23	46	78	43	7	250
	(17.6)	(3.6)	(9.2)	(18.4)	(31.2)	(17.2)	(2.8)	
P3q5_6	41	11	22	47	69	43	17	250
	(16.4)	(4.4)	(8.8)	(18.8)	(27.6)	(17.2)	(6.8)	

P3q5_1: Technology choice (i.e., partner, product) capability has been improved
P3q5_2: Modification capability of existing technology, process and product have been improved
P3q5_3: R&D, design and innovation capability have been improved
P3q5_4: Commercialisation and manufacturing capability have been improved
P3q5_5: Absorptive and learning capability has been improved
P3q5_6: Overall technological capability has been improved

A total of 250 firms responded on the above six items. Roughly speaking, based on the question of whether the technology cooperation activities have contributed to improving the innovative capability, the dominant respondents show largely three most frequent opinions: strongly disagree, somewhat agree or have no idea. For instance, based on the question item p3q5_2 (whether the technology cooperation activities have contributed to their modification capability of existing technology, process and product), 22.0 % of the respondents replied that it has disappointedly contributed far less than expected, 23.6 % of the respondents replied that they could not evaluate the impact and 25.2 % of them replied that it somewhat contributed. Similarly, based on the question item p3q5_4 (whether the technology cooperation activities had contributed to their commercialization and manufacturing capability), 21.2 % of the respondents replied that it had contributed far less than they expected, 24.0 % of them replied that they cannot evaluate and 25.2 % of them replied that it contributed somewhat.

The general impression from respondents' opinions is that they perceive that the technological cooperation activities have improved the innovative capability of the firms only marginally at best. Descriptive analysis (the central tendency and dispersion of the respondents' opinions) is conducted to further elaborate on the respondents' perception of the impact of technology cooperation activities.

Descriptive Statistics of the overall impact of technology cooperation activity

	N	Minimum	Maximum	Sum	**Mean**	Std. Deviation	Variance
P3q5_1	250	1	7	964	**3.86**	1.766	3.120
P3q5_2	250	1	7	923	**3.69**	1.794	3.218

P3q5_3	250	1	7	924	**3.70**	1.769	3.128
P3q5_4	250	1	7	923	**3.69**	1.774	3.146
P3q5_5	250	1	7	1012	**4.05**	1.756	3.082
P3q5_6	250	1	7	1039	**4.16**	1.818	3.305
Valid N (listwise)	250						

The result of the descriptive statistics is shown in the above table. All variables were tapped on a seven-point scale in which 1 indicates strongly disagree and 7 indicates strongly agree on the six questions items given. The standard deviation of each item is not high, indicating that most respondents are very close to the mean value on all variables. From the results, it is seen that, regarding the questions of the first four items (p3q5_1, p3q5_2, p3q5_3 and p3q5_4), the respondents expressed that the role of the technology cooperation activity on innovation capability is less satisfactory. For the fifth question item (p3q5_5), the responding firms expressed a neutral position and for the sixth question item (p3q5_6), the responding firms show a very marginal satisfaction with the impact of their technology innovation activities. The mean score of the six items together is 3.86, indicating that the respondents perceive that their technology cooperation activities are somewhat less satisfactory in improving their innovation capability, in general.

Conclusion

In summary, we have seen that Korean HTSFs have been actively engaged in various types of formal and informal technology cooperation with others, in order to supplement technological knowledge. Equity-based technology alliance is employed by a limited number of firms due to its cost of management and burdensome mutual commitment. Non-equity alliance is more popular because it is more efficient and convenient to form and solid to the technology development project. The study found that informal relationships with government bodies, customers and competitors are an important source of getting valuable technological information necessary to the technology/product development. Nevertheless, the survey found that the actual effects of such activities fall short of the firms' expectations.

Wider use of technological cooperation reflects the innovation effort of Korean HTSFs. Although there is no official data on to what extent these activities have increased, this study does not challenge that such increase is an obvious phenomenon among them. Nevertheless, it is found that there is no guarantee that such use of technology cooperation has consistently improved the innovation capability of the firms. As noted elsewhere, technology alliance is not always translated into the competence of the firm, and it should only be undertaken where doing so is cost-effective and does not threaten the competitive advantages of the firm (Narula 2004). Keeping this in mind, it is of growing importance to study when and how these cooperative relationships should be formed. Of course, optimal conditions for choosing technology alliance do not necessarily guarantee its success. However, understanding it will help decision-makers decide to either "collaborate" or "avoid collaboration" in strategically important areas, with minimal risks of failure. Based on the survey results and theoretical predictions, the next chapters will focus on this issue by analysing how Korean HTSFs are reasoning in their decision-making.

Chapter 8: Determinants of technology-sourcing decision in stage one (hypotheses testing)

Based on the theoretical and empirical predictions, three antecedents (perceived internal capability of a firm, perceived technological attributes of the project, and perceived environmental condition surrounding the firm) were proposed as essential determinants in the technology-sourcing decision during the first stage of contingency model. Each antecedent consists of several observable factors from which testable hypotheses were generated. This chapter will summarise the results of the hypotheses tests in stage one and demonstrate their statistical significance and implication.

To gain better understanding of the complex phenomenon, multivariate analysis is essential[13]. Based on the most significant technology development project to the core business of the responding firms during the past three years, 258 responding firms exhibit the following results.

Method of new technology/product development project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Technology alliance	63	24.4	24.4	24.4
	In-house development	195	75.6	75.6	100.0
	Total	258	100.0	100.0	

24.4 % of the respondents (63 firms) have chosen technology alliance while 75.6 % of the respondents (195 firms) have chosen in-house development as a way of conducting the new technology development project. Only one quarter of the respondents have chosen the cooperative mode for the project. This study tests whether technology-sourcing decision would differ between firm types (listed vs. non-listed) as listed firms are believed to be more active in technological cooperation. The Chi-square test based on 2X2 cross-tabulation shows that its value is only 0.003 which is much smaller than 3.841 with df=1 at α=0.05. So, we fail to reject the null hypothesis that there is no relationship between technology-sourcing decision and firm type.

The strategic alliance as an organisational competitive strategy is one which has excited a great deal of attention. Ohmae (1990), for example, argues that strategic alliance is mandatory and an essential strategy in this

[13] Multivariate analysis is an extension of bivariate or univariate analysis. Broadly speaking, it refers to all statistical methods that simultaneously analyse multiple measurements on each individual or object under investigation. Any simultaneous analysis of more than two variables can be loosely considered as multivariate analysis. To be truly multivariate, however, all the variables must be random and interrelated in such ways that their different effects cannot be meaningfully interpreted separately (Hair, et al. 1998). As noted earlier, logistic regression will be used for a multivariate analysis.

globalised environment. Others develop a similar line: to find the right domestic or international partners has become a central strategic issues for most firms, an issue which is as important as the level and direction of spending on research and development (Dodgson 1993). The impression from the survey is that these are exaggerated, as far as Korean HTSFs are concerned; in-house R&D is, and will remain the basis for firms' competitive efforts and knowledge accumulation.

In fact, the Korean government's research has already revealed similar results from its study of small firms' cooperative activities in seven major business areas (see Chapter 3, pp.70); only one-third of them are actually using strategic alliance for innovation activity. The finding of both surveys is consistent with the TC perspective which argues that in-house development or internalisation is the default of undertaking economic activity and strategic alliance is undertaken on an exceptional basis (e.g., Gulati 1995). As the TC perspective predicts, it appears that the respondents value the fullest ownership and administrative control of the innovation activity with the fewest transaction costs possible, associated with their strategic decision. They try to exploit the valuable opportunities, in order to maximise profit. Thus, initiating technology projects internally is a more attractive option; in-house R&D still remains the base for Korean HTSFs' technological accumulation, and technology alliance can only provide a useful supplement.

Considering the relatively small number of respondents involved in formal cooperation for technology innovation, it is more intriguing to investigate whether proposed antecedents play any significant role in such a pattern. This will be examined in the next section.

8.1 Descriptive analysis on the internal capability of a firm and technology-sourcing decision

Four observable factors constitute the internal capability of a firm: perceived level of the technological capability of a firm, previous in-house R&D experience in the relevant area, propensity to choose a specific sourcing method (in-house development, for instance), and perceived level of the strategic orientation of the entrepreneur. Each factor will be examined in terms of its measurement of goodness, and descriptive characteristics (reaction of the respondents on the question items) first. Cronbach's alpha and factor analysis will be used for examining reliability, and factor analysis for validity of the measurement. 0.6 will be used as cur-off point for the Cronbach's coefficient alpha. Then, the hypothesised impact on the technology-sourcing will be addressed.

■ Measurement of goodness and descriptive analysis

Perceived level of the technological capability of a firm

Five items were used for measuring perceived level of the technological capability of a firm.

Reliability test

```
Reliability Coefficients
N of Cases =    258.0                    N of Items =  5
Alpha =    .7421
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Cronbach's alpha for the measurement of five items is 0.74. This figure reflects that the measurement is internally consistent and reliable.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.500	50.010	50.010	2.500	50.010	50.010
2	.839	16.789	66.799			
3	.713	14.258	81.057			
4	.509	10.183	91.240			
5	.438	8.760	100.000			

Extraction Method: Principal Component Analysis.

According to the table above, only one factor (component) has Eigenvalue greater than 1 (2.500), indicating that five different variables as a set of measurement accurately represent only one concept of interest, the perceived technological capability of a firm. The factor 1 (component 1) explains 50.010 % of the variation of the five measurement items. This is quite good explanatory power of the factor 1. In summary, the key concept (innovative capability of a firm) is tapped by six measurement items correctly and the validity of the measurement is very good. The following is the summary of the reliability and validity test of the measurement.

Variable	Item (item name)	Factor loading (factor 1)	Cronbach's alpha
Perceived level of the technological	R&D facility (p1q3_1)	0.770	0.742
	New product (technology) development capability (p1q3_3)	0.732	
	Management capability (pq3_2)	0.711	
	R&D spending and investment (p1q3_4)	0.693	

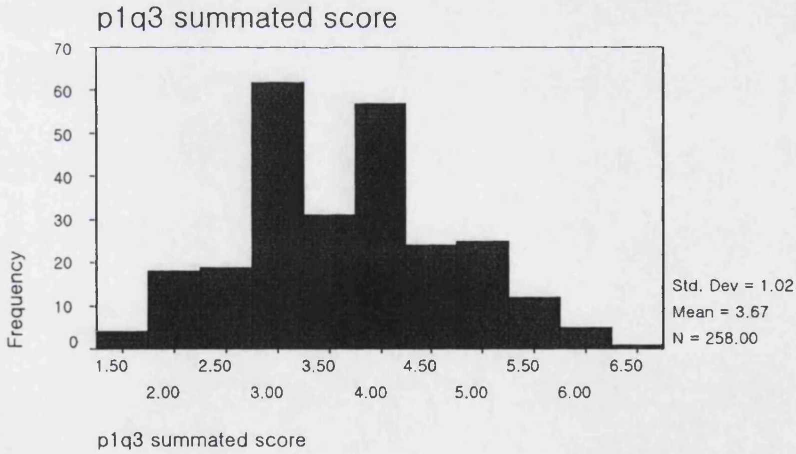
capability of a firm (compare d to the industry leader)	Number of patent or intellectual properties (p1q3_5)	0.620	

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

The factor loading value indicates what percentage of the variance in an original variable is explained by each item. Normally, ±0.4 is considered significant. Five items have factor loading values larger than 0.4, significant to the variation of the factor 1. Each item is ordered by the level of the significance to the variation of the factor 1.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
p1q3 summated score	258	5.200	1.400	6.600	3.66899	1.016770	1.034
Valid N (listwise)	258						

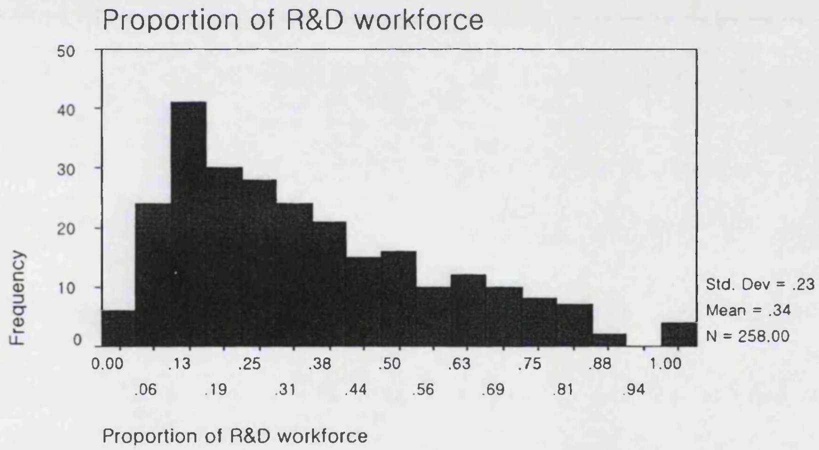


The above descriptive statistics show the respondents' evaluation of their technological capability, varying from much inferior (1.4) to much superior (6.6) compared to the industry leader. The histogram shows that their self-capability evaluations vary widely. According to it, 58.9 % of the respondents perceive that they are less technologically capable than the industry leader while 33 % of them believe that they are more capable than the industry leader. However, we see that many respondents perceive that their technological capability is not necessarily radically inferior to their industry leader as the evaluation score scatters around between 3.0 and 4.0. On average, they perceive that their technological capability is slightly less equivalent to the industry leader-the mean score being 3.668 with 1.02 standard deviation.

On the other hand, the relative number of R&D workers (total number of R&D workers divided by the total number of employees) is used as an alternative measurement of the technological capability at the time the technology project was planned. The proportion of R&D workers varies from continuum 0 to 1. Closer to 1 indicates the more technologically-capable the firm is.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Proportion of R&D workforce	258	.983	.017	1.000	.33625	.231212	.053
Valid N (listwise)	258						



Seen in the table above, the respondents' proportion of the R&D workers varies widely from 0.017 to 1.00. 33.625 % is the average rate of R&D workers per total employees, indicating that, on average, the respondents hire one out of three employees as R&D workers. The figures of standard deviation (0.231212) and (0.053) show that the proportion of R&D workers are moderately spread around the mean value, however, seen in the histogram, it is highly skewed to the left side.

Previous in-house R&D experience in relevant area

A dummy variable is used to define the existence of previous in-house R&D experience in the relevant area. 1 is coded if the respondents have a relevant experience previously and 0 otherwise in the logistic regression model.

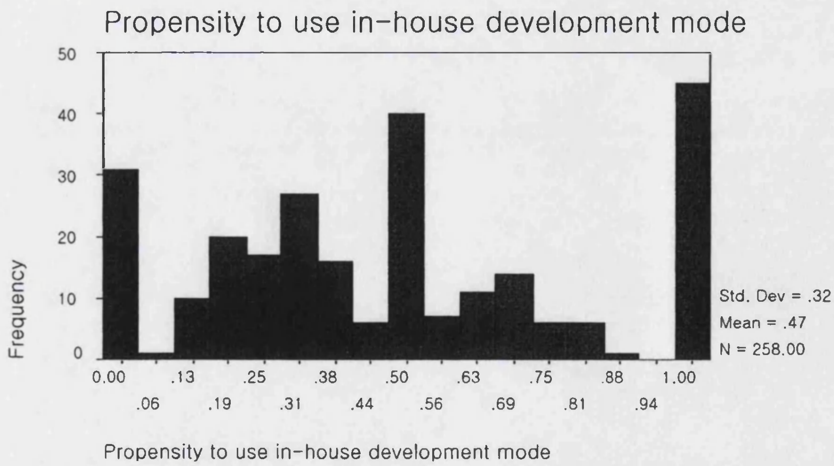
Previous in-house R&D experience in relevant area

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes. We had previous experiences in relevant area	158	61.2	61.2	62.2
	No. We had no previous experience	100	38.8	38.8	100
	Total	258	100.0	100.0	

The survey says that 61.2 % of the respondents are involved in new projects that are related to their previous projects while 38.8 % of the respondents are involved in the new projects that they have inexperienced previously. It is assumed that more than half of the respondents try to find new technological opportunities from the familiar technological areas, in order to better exploit the opportunities. Comparatively, the respondents are less interested in exploring new technological opportunities to reduce the potential risk of project failure.

Propensity to choose specific technology-sourcing mode (routine response)

Using the in-house development as a default mode, we have investigated the proclivity of using in-house development method out of their total number of technology projects, during the period before the new technology development project being asked. The proclivity is figured out by the total number of in-house developments divided by total number of technology developments.



On average, the respondents show that slightly less than half of the total technology development has been carried out by in-house development (propensity = 0.4741). However, the figure of the standard deviation (0.318) and variance (0.10161) indicates that the proclivity is widely varied. The histogram above, for instance, shows that more than 40 respondents are solely reliant on in-house development for all of their previous technology projects, more than 30 respondents are solely dependent on non-in house method (i.e., strategic alliance or outsourcing) and 40 respondents have equally used in-house and non- in-house methods for all of their technology projects. The reason for widely-varying proclivity to technological project methods is not clear. However, it will be interesting to investigate whether a firm's previous proclivity for certain governance mode would influence its next technology project in a similar way.

Perceived level of strategic orientation of the entrepreneur (entrepreneurial orientation)

Eight items were used for measuring perceived strategic orientation of the entrepreneur.

Reliability test

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Reliability Coefficients
N of Cases =    258.0                    N of Items = 8
Alpha =    .7570
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Cronbach's alpha for the eight-item measurement is 0.7570. The internal consistency and reliability of the measures used in this study can be considered quite good.

Reliability test

```
Reliability Coefficients
N of Cases =    258.0
N of Items =  6 (p1q5_1,p1q5_2, p1q5_3, p1q5_4, p1q5_5, p1q5_8)
Alpha =    .7710
```

However, as seen in the table above, without the question items p1q5_6 and p1q5_7, the internal reliability of the measurement is improved to 0.7710. Therefore, the question items excluding these two items will be used for the final analysis of the validity test and the impact of the perceived level of the strategic orientation of the entrepreneur.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.827	47.121	47.121	2.827	47.121	47.121

2	.764	12.726	59.847			
3	.736	12.262	72.108			
4	.694	11.573	83.681			
5	.546	9.101	92.783			
6	.433	7.217	100.000			

Extraction Method: Principal Component Analysis.

One component is well identified in the validity test. According to the table above, one factor (component) having Eigenvalue greater than 1 (2.827 for component 1) is considered significant. This reflects that six question items as a set of measurement accurately represent one concept of interest, the perceived level of the strategic orientation of the entrepreneur (entrepreneurial orientation), by measuring one dimension of it. Factor 1 (component 1) can explain 47.121 % of the total variation of the six question items. This is good explanatory power of the factor 1. The following is the summary of the reliability and validity test of the measurement for variable.

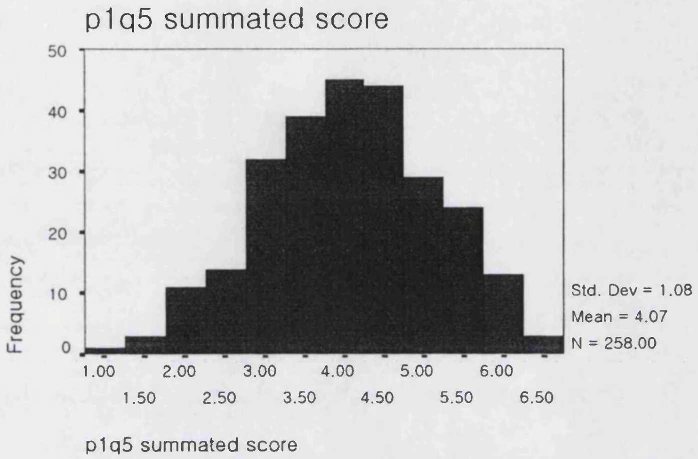
Variable	Item (item name)	Factor loading (factor 1)	Cronbach 's alpha
Perceived level of the strategic orientation of the entrepreneur	Responsiveness to the industrial environment (p1q5_4)	0.784	0.7710
	Risk taking propensity (p1q5_2)	0.727	
	Strategic posture to the potential opportunity (p1q5_8)	0.689	
	Reactiveness to the competitor's behaviour (p1q5_3)	0.657	
	Leadership in introducing technology/service/administrative technique (p1q5_5)	0.640	
	Leadership in R&D and technological innovation (p1q5_1)	0.608	

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

As seen in the table, the perceived level of the strategic orientation of the entrepreneur is represented by one factor, which was also measured by six measurement items. Factor loading is key to understanding the nature of a particular factor. The factor 1 is explained well by variable items p1q5_4, p1q5_8, p1q5_3, p1q5_5 and p1q5_1 (in order of their significance to the factor 1) whose factor loading values are larger than 0.4. Factor 1 represents an entrepreneur's strategic orientation in terms of product innovation, risk-taking and proactiveness to the competitive environment and new product/technology innovation.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
p1q5 summated score	258	5.333	1.167	6.500	4.06654	1.081817	1.170
Valid N (listwise)	258						



The descriptive statistics demonstrate that the various respondents perceive themselves from weakly entrepreneur-oriented (i.e., very conservatively-oriented) to highly entrepreneur-oriented, ranging the score from 1.167 to 6.500. The standard deviation score (1.08) shows that the distribution tends to be normally distributed around the mean value. On average, they perceive themselves as well poised between conservative-oriented and entrepreneur-oriented as the mean score is 4.07. According to the histogram, 44.2 % of the respondents perceived that they are rather conservatively-positioned, 7.1 % are neutral and 48.8 % of them perceived themselves as entrepreneurially-oriented for their strategic decision-making. As Autio (1994) argued, high-tech small ventures are not always willing to take risk and fiercely growth-oriented; we found that Korean HTSFs are not exceptional.

8.2 Descriptive analysis on the perceived project factors and technology-sourcing decision

Three observable factors are representative to the characteristics of the technology project: perceived level of specialised asset investment, perceived life cycle phase of technology and perceived level of technology uncertainty. Each factor will be examined with respect to its measurement of goodness, descriptive characteristics (reaction of the respondents on the question items) and hypothesised impact on the technology-sourcing decision.

■ **Measurement of goodness and descriptive analysis**

Perceived level of specialised asset investment (Technology/product specific asset)

Ten items were used for measuring perceived level of specialised asset investment.

Reliability test

```
Reliability Coefficients
N of Cases =    258.0                    N of Items = 10
Alpha =    .7699
```

Cronbach's alpha for the measurement of the ten items is 0.7699. The internal consistency reliability of the measures can be considered good and acceptable.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.356	33.564	33.564	3.356	33.564	33.564	2.166	21.658	21.658
2	1.678	16.780	50.344	1.678	16.780	50.344	2.038	20.384	42.041
3	1.041	10.413	60.758	1.041	10.413	60.758	1.872	18.717	60.758
4	.907	9.070	69.828						
5	.667	6.670	76.497						
6	.636	6.359	82.856						
7	.514	5.144	88.000						
8	.465	4.645	92.645						
9	.399	3.986	96.631						
10	.337	3.369	100.000						

Extraction Method: Principal Component Analysis.

The table above shows that three factors (components) having Eigenvalue greater than 1 (3.356 for component 1, 1.678 for component 2 and 1.041 for component 3) are considered significant. This indicates that ten different variable items as a set of measurement accurately represent one concept of interest, the perceived level of specialised asset investment, by measuring three dimensions of it. Factor 1 (component 1) can explain 33.564 % of the total variation of the ten variables, factor 2 (component 2) can explain 16.780 % of the total variation of the ten variables, and factor 3 (component 3) can explain 10.413 % of the total variation of the ten variables. Factor 1, 2 and 3 together can explain a 60.758 variation of the ten variables. This is quite good explanatory power of the factor 1, 2 and 3.

The following is the summary of the reliability and validity test of the measurement.

Variable	Items (item name)	Factor loading (factor 1)	Factor loading (factor 2)	Factor loading (factor 3)	Cronbach's alpha
The perceived level of specialized asset investment	The project is very significant to the core competence of my firm (p1q10_6)	**.819**	.152	.064	0.7699
	The level of the product (technology) sophistication is very high (p1q10_10)	**.788**	.102	-.013	
	Our firm has dedicated high level of professional know-how to the project (p1q10_2)	**.573**	.493	.024	
	My firm has dedicated a major marketing commitment to the project (p1q10_5)	**.543**	.136	.106	
	Our firm has dedicated a significant amount of plant and equipment to the project (p1q10_3)	.048	**.785**	.121	
	Our firm has dedicated high levels of personnel to the project (P1Q10_1)	.174	**.744**	.135	
	Our firm has dedicated high levels of financial resources to the project (P1Q10_4)	.396	**.725**	.094	
	Once people and equipment are redeployed for other use, their values are highly depreciated (p1q10_7)	.136	.054	**.810**	
	It is very difficult to re-deploy the people and equipment for other use, once the project is stopped (p1q10_8)	.158	.068	**.774**	
	The use of technological know-how acquired in the project is not much use to the other project (p1q10_9)	-.135	.202	**.748**	

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

As seen in the table, the perceived level of specialized asset investment consists of and is represented by three factors which are also measured by ten measurement items. The table above shows that the factor 1 is explained well by variable items p1q10_6, p1q10_10, p1q10_2 and p1q10_5 (in order of their significance to the factor 1), factor 2 is explained well by the variable items p1q10_3, p1q10_1 and p1q10_4 (in order of their significance to factor 2) and factor 3 is explained well by the variable items p1q10_7, p1q10_8 and pq10_9. Factor 1 represents the perceived level of specialized intangible (knowledge and know-how) asset investment to the technology project. Factor 2 represents the perceived level of specialised tangible (plant, human and financial resource) asset investment to the technology project. Factor 3 represents the perceived level of redeployability of the invested assets to the project in general. Three essential aspects were already addressed in the earlier chapter (Chapter 5), so that the finding of the three factors is valid.

Having found that three distinctive aspects exist in the respondents' perceived level of the specialized asset investment, it will be interesting to investigate how these will impact the technology-sourcing decision individually, instead of combining all these together as one variable. The following table is the validity of each individual factor.

Validity of each three factor

```
Factor 1
N of Cases =     258.0
N of Items =  4 (p1q10_2, p1q10_5, p1q10_6, p1q10_10: perceived level of specialized
intangible asset investment)
Alpha =    .7065

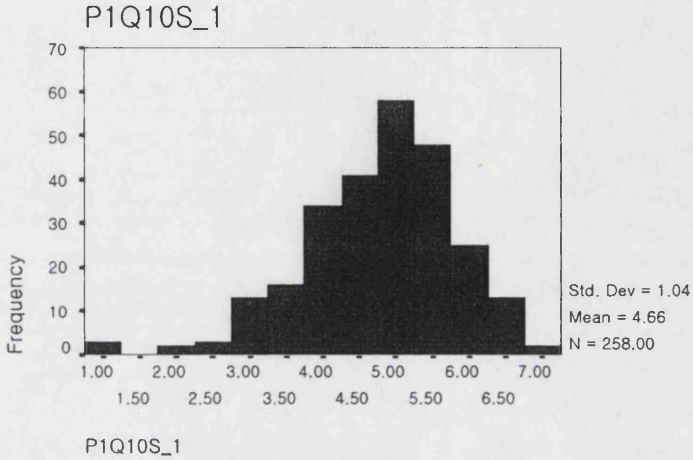
Factor 2
N of Cases =     258.0
N of Items =  3 (p1q10_1, p1q10_3, p1q10_4: perceived level of specialized tangible
asset investment)
Alpha =    .7202

Factor 3
N of Cases =     258.0
N of Items =  3 (p1q10_7, p1q10_8, p1q10_9: perceived level of redeployability of the
invested asset to the project)
Alpha =    .6902
```

Shown above, Cronbach's alpha values for the measurement of each three factors are 0.7065, 0.7202 and 0.6902. The internal consistency and reliability of the measurement for each factor can be considered good and acceptable. Thus, three factors will be individually used for the final analysis. For the convenience of the analysis, factor 1 is named as p1q10s_1, factor 2 as p1q10s_2 and factor 3 as p1q10s_3 (each represents a summated score from relevant items). The following is the descriptive analysis of each factor.

Descriptive Statistics for factor 1 (P1Q10S_1: perceived level of specialized intangible asset investment)

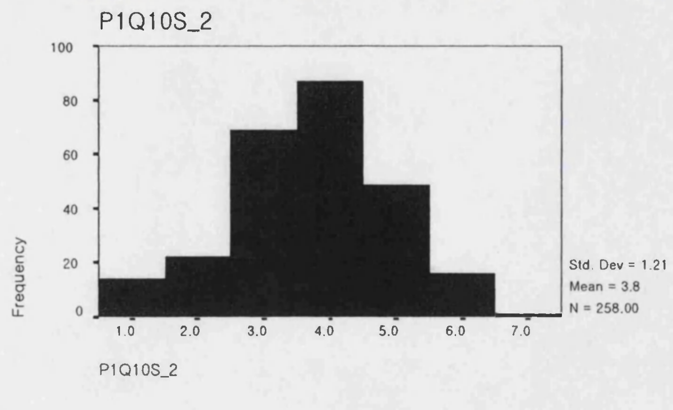
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
P1Q10S_1	258	6.000	1.000	7.000	4.65795	1.041458	1.085
Valid N (listwise)	258						



The respondents' perceived level of the specialised intangible asset investment (noted as p1q10s_1) to the project ranges from very weakly specialised (1.0) to very highly specialised (7.0). On average, the respondents' perceived level is somewhat neutral as the mean score is 4.66. However, the histogram shows that the distribution is skewed to the right side, implying that dominant respondents perceive that their technology projects tend to involve some degree of specialised intangible asset investment. 20.2 % of the respondents perceived that the technology project involved no-serious specialised intangible asset investment, 7.4 % of them showed a neutral opinion and 72.5 % of them perceived that their technology project involves more than a moderate level of the specialised intangible asset investment to the projects.

Descriptive Statistics for factor 2 (P1Q10S_2: perceived level of specialized tangible asset investment)

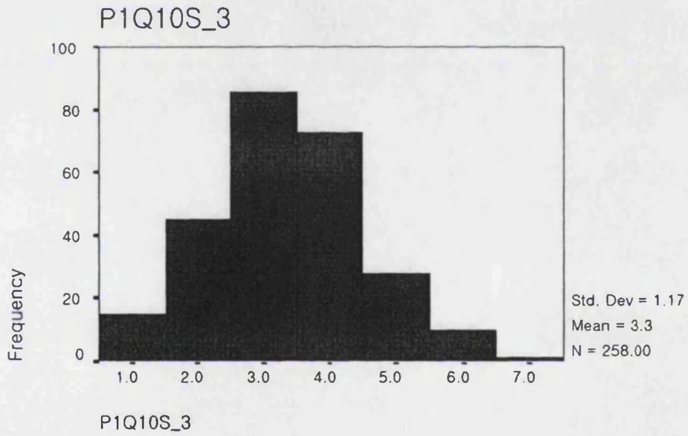
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Varianc e
P1Q10S_2	258	6.000	1.000	7.000	3.76615	1.207059	1.457
Valid N (listwise)	258						



Regarding the perceived level of the specialized tangible asset investment (noted as p1q10s_2), the respondents perceived it from very weakly specialized (1.0) to very highly specialised (7.0). On average, the respondents perceived specialized tangible asset investment level is somewhat less than neutral, implying that specialized tangible asset investment is not seriously involved in the project (mean score is 3.8). This can be noticed visually from the histogram above. Compared to the intangible asset investment, we find that specialized tangible asset investment is not seriously involved in the projects. The projects seem to be more focused on specialized intangible assets investment.

Descriptive Statistics for factor 3 (P1Q10S_3: perceived level of redeployability of the invested asset)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
P1Q10S_3	258	5.667	1.000	6.667	3.33463	1.173456	1.377
Valid N (listwise)	258						



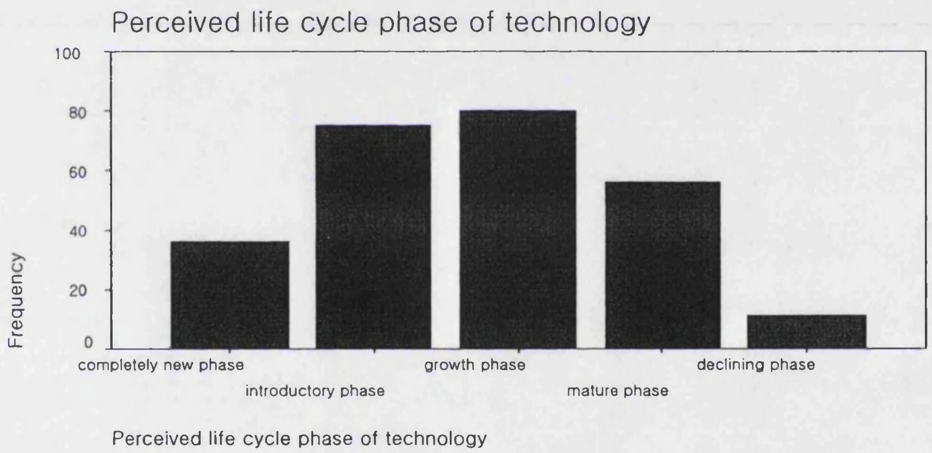
Finally, the respondents' perceived level of the redeployability of the invested assets to the projects (represented as p1q10s_3) is also widely varying from highly redeployable (1.0) to highly non-redeployable (6.67). On average, the level is somewhat redeployable to other technology projects (the mean score is 3.3). The histogram above shows 67.8 % of the respondents perceived that invested assets are rather redeployable to other project, 10.9 % of them perceived neutral and 21.3 % of them perceived that they are rather hard-to redeploy. In summary, we found that perceived level of the specialised asset investment tends to be high for intangible asset and low for tangible assets. However, we found that redeployability of invested assets is not really limited to the project only. This may be from the fact that the boundary of specialised know-how in high-tech industry is blurred and knowledge can be applied and modified for other related industries.

Perceived life cycle phase of technology (stage in technology life cycle)

The following table reveals how the respondents perceived the status of the new technology project according to technology life cycle stage.

Perceived life cycle phase of technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely new phase	36	14.0	14.0	14.0
	Introductory phase	75	29.1	29.1	43.0
	Growth phase	80	31.0	31.0	74.0
	Mature phase	56	21.7	21.7	95.7
	Declining phase	11	4.3	4.3	100.0
	Total	258	100.0	100.0	



31 % of the respondents said that their developing technology is in a growing phase, 29.1 % of them said it is in a introductory phase and 14 % of them said it is in a completely new phase. On the other hand, 21.7 and 4.3 % of the respondents perceived that their projects are aiming at the mature and declining phase of technology, respectively. Over all, two thirds of the respondents believed that the technology they intended to develop was in the early and growing phase of technology. This is partly influenced by the fact that the history of Korean telecommunications industry and players is not that long and they have been growing and developing quite recently.

Perceived level of the technology uncertainty

Cronbach's alpha and factor analysis are used to test the reliability and validity of the perceived level of technology uncertainty measured by five items.

Reliability test

```
Reliability Coefficients
N of Cases =    258.0                   N of Items =  5
Alpha =     .9354
```

Cronbach's alpha for the measurement of five items is 0.9354. The internal consistency and reliability of this measurement can be considered very good.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.979	79.576	79.576	3.979	79.576	79.576
2	.359	7.174	86.750			
3	.267	5.344	92.094			
4	.210	4.195	96.289			
5	.186	3.711	100.000			

Extraction Method: Principal Component Analysis.

According to the above table, only one factor (component) has Eigenvalue greater than 1 (3.979), indicating that five different items as a set of measurement accurately represent only one concept of interest, the perceived level of the technology uncertainty. 79.576 (cumulative %) indicate that the factor 1 (component 1) explains 79.576 % of the variation of the five variable items. The explanatory power of the factor 1 is very strong. In summary, the key concept (perceived level of technology uncertainty) is tapped correctly by five measurement items correctly and the validity of the measurement is very good. The following is a summary of the reliability and validity test of the measurement.

Variable	Item (item name)	Factor loading (factor 1)	Cronbach's alpha
Perceived level of the technolog y uncertaint y	We were confident that this technology would meet our technical expectation (p1q11_2)	.901	0.9354
	We were confident that this technology would meet the customer demand (p1q11_3)	.900	
	We were confident that this technology which the project will develop would achieve our market goal (p1q11_1)	.891	
	We were confident that the technology would be a commercial success (p1q11_5)	.887	
	It is confident that this technology would work as it was intended and designed technologically (p1q11_4)	.881	

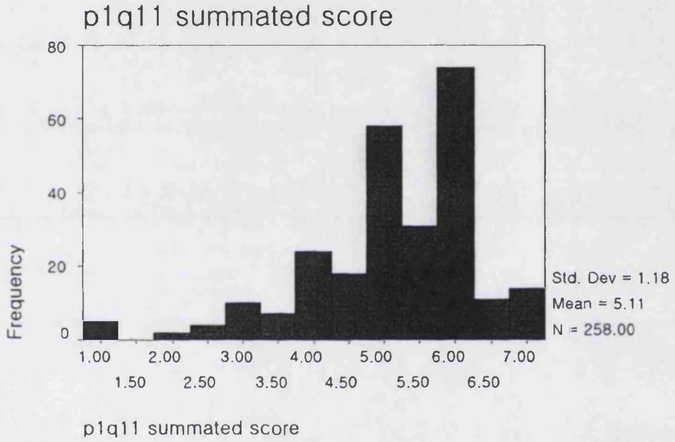
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser

Normalization.

All the factor loading values are larger than 0.4. Each item is ordered by the level of the significance to the variation of the factor 1.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
p1q11 summated score	258	6.000	1.000	7.000	2.88760	1.179297	1.391
Valid N (listwise)	258						



The perceived level of the technology uncertainty varies from highly uncertain (7.0) to highly certain (1.0). On average, the respondents perceive that the attribute of the technology being developed is somewhat uncertain (5.11). The histogram also shows that the perception of the respondents is highly skewed to the left-side; 82.6 % of the respondents perceive more than a moderate degree of technology uncertainty on their project.

8.3 Descriptive analysis on the perceived environmental factors and technology-sourcing decision

Three observable factors are representative of the characteristics of the technology project: perceived level of the environmental uncertainty, perceived level of the market growth and perceived level of legitimacy of the alliance. Each factor will be examined with respect to its measurement of goodness, descriptive characteristics (reaction of the respondents to the question items) and hypothesised impact on the technology-sourcing decision.

Measurement of goodness and descriptive analysis

Perceived level of the environmental uncertainty

Eight items were used for measuring perceived level of the environmental uncertainty.

Reliability test

```
Reliability Coefficients
N of Cases =    258.0                    N of Items =  8
Alpha =     .6651
```

Cronbach's alpha for the measurement of the eight items is 0.6651. The internal consistency reliability of the measures used in this study can be considered good. However, as seen in the table below, the Cronbach's alpha value is improved when we delete one of the question items (p1q6_1 from the total eight items measured for the perceived level of the environmental uncertainty).

Reliability test

```
Reliability Coefficients
N of Cases =    258.0                    N of Items =  7 (excluding p1q6_1)
Alpha =     .6735
```

Therefore, only six items (from p1q6_2 to p1q6_8) are used for the validity test.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.425	34.639	34.639	2.425	34.639	34.639	2.023	28.895	28.895
2	1.135	16.218	50.857	1.135	16.218	50.857	1.537	21.962	50.857
3	.936	13.365	64.222						
4	.804	11.480	75.702						
5	.616	8.798	84.500						
6	.589	8.413	92.913						
7	.496	7.087	100.000						

Extraction Method: Principal Component Analysis.

The table above shows that two factors (components) having Eigenvalue greater than 1 (2.425 for component 1 and 1.135 for component 2) are considered significant. This indicates that seven different items (variables) as a set of measurement accurately represent one concept of interest, the perceived level of environmental uncertainty, by measuring two dimensions of it. Factor one (component 1) can explain 34.639 % of the total variation of the seven variables and factor 2 (component 2) can explain 16.218 % of the total variation of seven variables. Factor 1 and 2 together can explain 50.857 % of the variation of the seven variables. This is good explanatory power of the variation of the seven variables. The following is the summary of the reliability and validity test of the measurement.

Variable	Items (item name)	Factor loading (factor 1)	Factor loading (factor 2)	Cronbach's alpha
The perceived level of environmental uncertainty	General and overall industry competition level (p1q6_7)	**.773**	-.069	0.6735
	The level of the control and manipulation of the environment (p1q6_8)	**.674**	.282	
	The level of threat to the survival and well-being of the firm (p1q6_6)	**.602**	.422	
	The rate of product/technology/service obsolescence (p1q6_3)	**.571**	-.057	
	The frequency and extent of change in mode of production/service (pq6_2)	**.519**	.243	
	Predictability of the competitor's action (p1q6_5)	.038	**.793**	
	Predictability of the customer demand and taste (p1q6_4)	.108	**.764**	

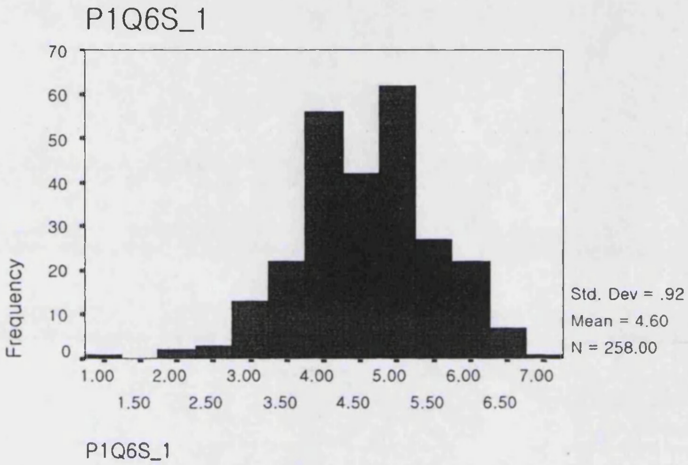
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

As seen in the table, the perceived level of the environmental uncertainty consists of and is represented by two factors which are also measured by seven measurement items. The table above shows that the factor 1 is explained well by variable items plq6_7, plq6_8, plq6_6, plq6_3 and plq6_2 (in order of their significance to the factor 1) and factor 2 is explained well by the variable items plq6_5 and plq6_4 (in order of their significance to factor 2). Factor 1 represents the overall competition and uncertainty level that the responding firms perceive from their industrial and product market environment in general terms while Factor 2 represents the perceived level of predictability of the competitor and customers' action. For the convenience of the analysis, the factor 1 is named as plq6s_1 and factor 2 as plq6s_2 (each represents a summated score from relevant items).

In chapter 5, the literature suggested two aspects of perceived level of environmental uncertainty: the decision-maker's inability to predict how components of the environment might be changing (exogenous uncertainty) and unpredictability of consumer preference and competitors' strategic behaviour. Thus, the findings of the two aspects of perceived environmental uncertainty are valid. The followings are descriptive analyses of each factor.

Descriptive Statistics for p1q6s_1 (over all perceived level of environmental uncertainty regarding industry and product market)

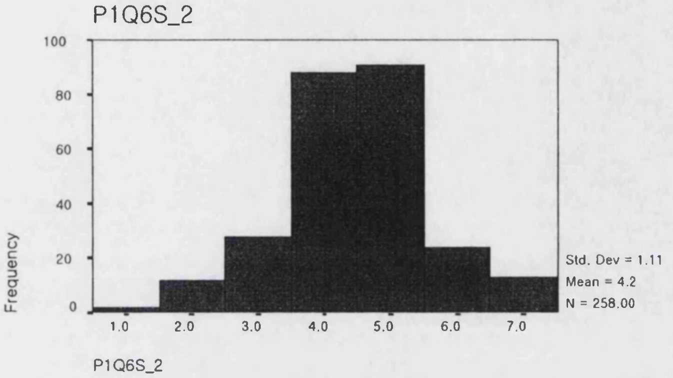
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
P1Q6S_1	258	5.800	1.000	6.800	4.59690	.915405	.838
Valid N (listwise)	258						



The descriptive statistics shows that respondents' perceived level of the industrial and product market environment ranges from very stable (1.0) to highly unstable and volatile (6.80). On average, the respondents perceived that their industrial and product market environment was somewhat unstable and volatile (means score is 4.6). The standard deviation score shows that the distribution of the respondents' perception is gathered around the mean value. Histogram shows that the respondents' evaluation is rather skewed to the right side, implying that they tend to perceive that their industrial environment is volatile rather than stable. For instance, 21.3 % of the respondents perceive that their industrial and product market conditions tend to be stable, 8.2 % of the respondents perceive them neutral and 70.5 % of the respondents perceive that the conditions tend to be unstable.

Descriptive Statistics for p1q6_2 (perceived level of the environmental uncertainty in terms of customer taste and competitor's action)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
P1Q6S_2	258	6.000	1.000	7.000	4.24031	1.105523	1.222
Valid N (listwise)	258						



Similarly, the respondents' perceived level of predictability of customer taste and competitors' action also showed a wide range from very predictable (1.0) to highly unpredictable (7.0). On average, the respondents perceived that their customer taste and competitor's action is somewhat unpredictable (the mean score is 4.2; with standard deviation it is 1.11). According to the histogram, 27.1 % of the respondents perceived that their customer taste and competitors' action was fairly predictable, 23.3 % perceived that they were neutral and 49.9 % of the respondents perceived that their customer taste and competitor's action were not predictable. Based on these two dimensions of environmental uncertainty, we find that the responding firms are playing in a very unpredictable and unstable market.

Perceived level of the market growth

Cronbach's alpha and factor analysis are used for testing reliability and validity of the six items measurement for perceived level of the market growth, as seen in the table below.

Reliability test

```
Reliability Coefficients
N of Cases =     258.0                    N of Items =  6
Alpha =     .8089
```

Cronbach's alpha for the measurement of the six items is 0.8089. The internal consistency reliability of the measures used in this study can be considered good and acceptable. However, as seen below, the reliability of the measurement is much improved without the question items p1q7_5 and p1q7_6.

Reliability test

```
Reliability Coefficients
N of Cases =    258.0
N of Items =  4 (p1q7_1, p1q7_2, p1q7_3 and p1q7_4)
Alpha =    .8275
```

Therefore, only four items will be used for the validity test seen below.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.641	66.026	66.026	2.641	66.026	66.026
2	.529	13.236	79.262			
3	.494	12.348	91.610			
4	.336	8.390	100.000			

Extraction Method: Principal Component Analysis.

According to the above table, only one factor (component) having Eigenvalue greater than 1 (2.641 for component 1) is considered significant. That is, four different variable items as a set of measurement accurately represent one concept of interest, the perceived level of the market growth, by measuring one dimension of it. Factor 1 (component 1) can explain 66.026 % of the total variation of the four variables. This is quite good explanatory power of the factor 1 and 2. The following is the summary of the reliability and validity test of the measurement.

Variable	Item (item name)	Factor loading (factor 1)	Cronbach's alpha
Perceived level of the market growth	Customer demand is growing rapidly (p1q7_1)	.859	0.8275
	Demand of the firm's product category is volatile (p1q7_2)	.814	
	Product category growth is negligible (reversed) (p1q7_3)	.788	
	Our playing industry field is a high growth market (p1q7_4)	.788	

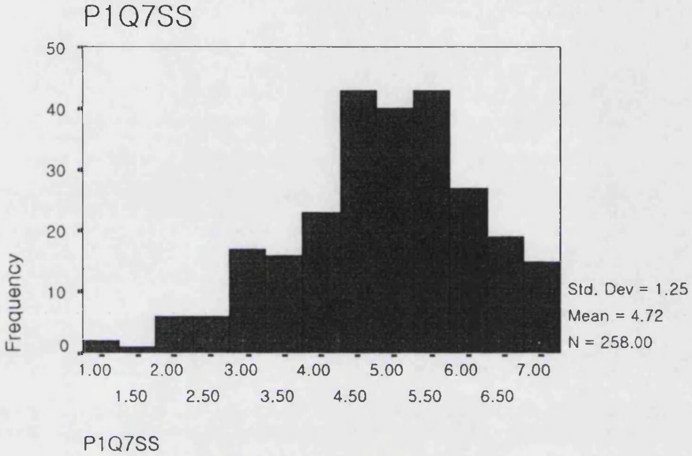
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

As seen in the table, the perceived level of the market growth consists of and is represented by one factor which is also measured by four measurement items. The factor 1 is explained well by variable items p1q7_1, p1q7_2, p1q7_3, and p1q7_4 (in order of their significance to the factor 1) whose factor loading is larger than 0.4. Factor 1 represents perceived market growth in terms of customer, product and industry growth rate.

Descriptive Statistics

	N	Range	Minimu	Maximum	Mean	Std.	Variance

			m			Deviation	
P1Q7SS	258	6.000	1.000	7.000	4.72093	1.249758	1.562
Valid N (listwise)	258						



As seen in the descriptive statistics above, a varying degree of perceived level of the market growth rate was expressed by the respondents, ranging from the lowest (1.00) to the highest (7.00). On average, the respondents perceived that their incumbent market is growing (the mean score is 4.72 with 1.24 standard deviation). This is well reflected in the histogram showing that 21.3 % of the respondents perceive that their incumbent market is not growing, 6.2 % perceive it as neutral and 72.5 % of the respondents perceived that their incumbent market is in the growing phase. We find that the dominant part of the respondents feel their market is fast-growing.

Perceived level of the legitimacy of the alliance

Five items were used for measuring perceived level of the legitimacy of the alliance. Cronbach's alpha and factor analysis were used for examining reliability and validity of the measurement, as seen in the table below.

Reliability test

```
Reliability Coefficients

N of Cases =    258.0                    N of Items =  5
Alpha =    .7065
```

Cronbach's alpha value for the measurement of five items is 0.7065. The internal consistency reliability of the measures used in this study can be considered good and acceptable.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.337	46.743	46.743	2.337	46.743	46.743
2	.960	19.191	65.934			
3	.750	15.007	80.941			
4	.586	11.715	92.656			
5	.367	7.344	100.000			

Extraction Method: Principal Component Analysis.

According to the above table, only one factor (component) has Eigenvalue greater than 1 (2.337), indicating that five different variable items as a set of measurements represent only one concept of interest, the perceived level of the legitimacy for alliance. 46.743 (cumulative %) indicates that the factor 1 (component 1) can explains 46.743 % of the variation of the five variables. This is an acceptable explanatory power of the factor 1. In summary, the key concept (innovative capability of a firm) is tapped by five measurement items correctly and the validity of the measurement is good. The following is the summary of the reliability and validity test of the measurement.

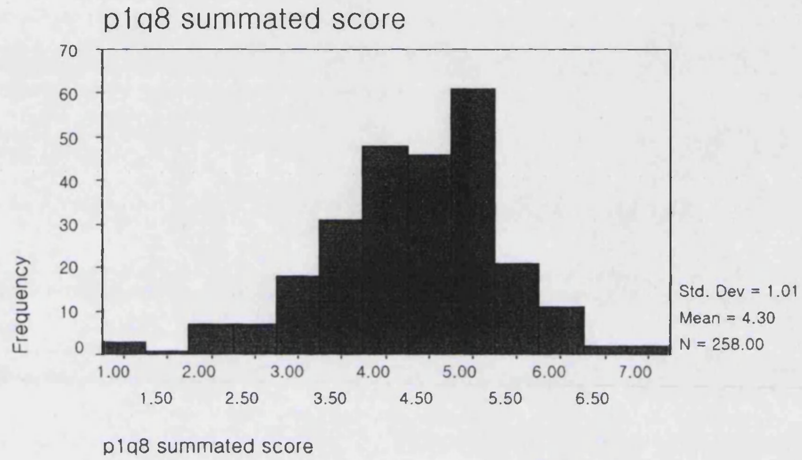
Variable	Item (item name)	Factor loading (factor 1)	Cronbach's alpha
Perceived level of the legitimacy of the alliance	Many firms in the industry seem to conceive that technology alliance is a strategic necessity for the success of technological innovation and competitive advantage of a firm (p1q8_1)	.816	0.7065
	Strategic technology alliance has become routine and in fashionable in the telecommunications industry (p1q8_3)	.760	
	We believe that strategic technology alliance would give a positive effect on the high tech firms and, if possible, we wish to form as many technology alliance as possible (p1q8_5)	.740	
	We feel pressured or threatened when we hear the announcement that competitors or firms in the same industry launch a new technology alliance relationships (p1q8_2)	.587	
	It is most often observed in the industry that strategic alliance is formed with other objectives rather than developing new technology (e.g., name recognition, reputation spillovers, networking effect, corporate image, stock price increase) (p1q8_4)	.451	

Extraction Method: Principal Component Analysis.
a 1 components extracted.

Five items have factor loading values larger than 0.4, significant to the variation of the factor 1. Each item is ordered by the level of the significance to the variation of the factor 1.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
p1q8 summated score	258	6.000	1.000	7.000	4.30233	1.014944	1.030
Valid N (listwise)	258						



On average, the respondents perceive somewhat that technology alliance is already established as an essential strategic tool in their industry (the average score is 4.3). But the degree of such perception among respondents is more severe when we observe the histogram above. About 60 % of respondents perceive that technology alliance is more than moderately important as their strategic tool.

8.4 Holistic approach to the multivariate analysis

As seen in the previous reliability and validity tests for measurement of all independent variables, we found that variable $\mathbf{X_5}$ and $\mathbf{X_8}$ consist of three and two distinctive dimensions respectively. Using them as new independent variables and adding control variables, we generate following full model.

$$\mathbf{Logit\hat{}} = \alpha \pm \beta_1 X_1 \pm \beta_2 X_2 + \beta_1 D_1 + \beta_3 X_3 - \beta_4 X_4 \pm \beta_{51} X_{51} \pm \beta_{52} X_{52} \pm \beta_{53} X_{53} \pm \beta_6 X_6 \pm \beta_7 X_7 \pm \beta_{81} X_{81} \pm \beta_{82} X_{82} \pm \beta_9 X_9 - \beta_{10} X_{10} - \beta_{14} X_{14} - \beta_{15} X_{15} \pm \beta_{16} X_{16}$$

The following three control variables will be included in the model.

Independent variable	Definition	Expected sign

X_{14}: P1q9ss	Perceived level of the government support for technological cooperation	-
X_{15}: P1q12	Perceived level of the financial costs of the development	-
X_{16}: Salesz	Sale size	**?**

The following table is the definition and expected signs of each independent variable.

Dependent Variable	Definition	Expected sign
Y = logit ^	Technology-sourcing decision 1= In-house development 2= Technology alliance	+:In-house develop-ment -:Technology alliance
Independent variable	**Definition**	**Expected sign**
X_1: P1q3ss	Perceived level of the technological capability of a firm	±*
X_2: Rdfr	Proportion of R&D workers	±*
D_1: P1q4	Previous in-house R&D experience in relevant area	+
X_3: PROPENSI	Propensity to choose in-house development method	+
X_4: P1q5ss	Perceived level of strategic orientation of the entrepreneur	-
X_{51}: p1q10s_1	Perceived level of the specialised asset investment (intangible assets)	±*
X_{52}: p1q10s_2	Perceived level of the specialised asset investment (tangible assets)	±*
X_{53}: p1q10s_3	Perceived level of the specialised asset investment (redeployability of the invested assets)	±*
X_6: P1q13	Perceived phase of the technology life cycle	±*
X_7: P1q11ss	Perceived level of technology uncertainty	±*
X_{81}: P1q6s_1	Perceived level of the environmental uncertainty (industry and product market)	±*
X_{82}: P1q6s_2	Perceived level of the environmental uncertainty ((customer taste and competitor's action)	±*
X_9: P1q7ss	Perceived level of the market growth	±*

X_{10}: P1q8ss	Perceived level of the legitimacy of the alliance	–

*: Two expected signs due to conflicting predictions

A correlation matrix is provided in the table below. The displayed pattern does not reveal a tendency towards high collinearity among the measures of the independent variables. The highest correlations are with H_{51} and X_{52} (r=0.507) and X_{51} and X_7 (r=-0.566). All other correlations are below 0.5.

Correlations

	X1	X2	D1	X3	X4	X51	X52	X53	X6	X7	X81	X82	X9	X10
X1	1	.090	.195 (**)	.143 (*)	.350 (**)	.367 (**)	.458 (**)	.106	-.244 (**)	-.339 (**)	.040	-.045	.103	.091
X2	.090	1	.044	.110	.207 (**)	.192 (**)	.156 (*)	-.019	-.094	-.030	.122	.033	.146 (*)	.169 (**)
D1	.195 (**)	.044	1	.029	.031	.230 (**)	.112	-.065	-.005	-.206 (**)	.015	-.079	.171 (**)	.083
X3	.143 (*)	.110	.029	1	.111	.124 (*)	.125 (*)	.037	-.062	-.049	.032	.025	.061	.080
X4	.350 (**)	.207 (**)	.031	.111	1	.405 (**)	.340 (**)	.032	-.343 (**)	-.329 (**)	.210 (**)	.130 (*)	.196 (**)	.207 (**)
X51	.367 (**)	.192 (**)	.230 (**)	.124 (*)	.405 (**)	1	.507 (**)	.171 (**)	-.127 (*)	-.566 (**)	.271 (**)	.054	.253 (**)	.371 (**)
X52	.458 (**)	.156 (*)	.112	.125 (*)	.340 (**)	.507 (**)	1	.287 (**)	-.153 (*)	-.281 (**)	.194 (**)	.099	.184 (**)	.288 (**)
X53	.106	-.019	-.065	.037	.032	.171 (**)	.287 (**)	1	.051	-.125 (*)	-.051	-.008	-.069	.209 (**)
X6	-.244 (**)	-.094	-.005	-.062	-.343 (**)	-.127 (*)	-.153 (*)	.051	1	.116	-.043	.012	.080	-.009
X7	-.339 (**)	-.030	-.206 (**)	-.049	-.329 (**)	-.566 (**)	-.281 (**)	-.125 (*)	.116	1	-.095	.106	-.231 (**)	-.317 (**)
X81	.040	.122	.015	.032	.210 (**)	.271 (**)	.194 (**)	-.051	-.043	-.095	1	.275 (**)	.450 (**)	.228 (**)

X82	-.045	.033	-.079	.025	.130 (*)	.054	.099	-.008	.012	.106	.275 (**)	1	**.128 (*)**	**.080**
X9	.103	.146 (*)	.171 (**)	.061	.196 (**)	.253 (**)	.184 (**)	-.069	.080	-.231 (**)	.450 (**)	.128 (*)	1	**.318 (**)**
X10	.091	.169 (**)	.083	.080	.207 (**)	.371 (**)	.288 (**)	.209 (**)	-.009	-.317 (**)	.228 (**)	.080	.318(**)	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

■ Result of the analysis

We tested the significance of the theoretical model by examining whether the addition of independent variables significantly improved the ability to explain the choice between in-house development and technology alliance. The logistic regression results for testing the 11 hypotheses are shown in the table below.

(Table 38) The result of logistic regression analysis in the 1st stage

	Dependent variable (technology-sourcing decision: (+ : In-house development, - : Technology alliance)					
Independent variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
X14 (p1q9ss)	-.146 (0.121)	-.163 (0.126)	-.153 (0.132)	-.188 (0.137)	-.050 (0.131)	-.105 (0.144)
X15 (p1q12)	-.045 (0.133)	-.044 (0.140)	.072 (0.15)	.067 (0.157)	.000 (0.135)	.086 (0.160)
X16 (salesz:SL)	-.112 (0.108)	-.048 (0.121)	-.096 (.113)	-.010 (0.128)	-.152 (0.111)	-.039 (0.130)
X1 (p1q3ss)		.081 (0.168)		.129 (0.181)		.066 (0.187)
X2 (rdfr)		1.860** (0.792)		2.254*** (0.827)		2.404*** (0.845)
D1 (PROPENSI)		.041 (0.310)		-.131 (0.336)		-.099 (0.346)
X3 (p1q4)		.283 (0.479)		.446 (0.505)		.563 (0.515)
X4 (p1q5ss)		-.333** (0.154)		-.385** (0.176)		-.386** (0.182)
X51 (p1q10s_1)			-.137 (0.211)	-.171 (0.225)		-.119 (0.238)
X52 (p1q10s_2)			-.264* (0.166)	-.301 (0.176)		-.253 (0.177)

X53 (p1q10s_3)			-.324** (0.138)	-.354** (0.150)		-.321** (0.154)
X6 (p1q13)			.052 (0.144)	.034 (0.155)		.060 (0.160)
X7 (p1q11ss)			-.338** (0.160)	-.459** (0.175)		-.503** (0.182)
X81 (p1q6s_1)					.159 (0.191)	.221 (0.209)
X82 (p1q6s_2)					-.208 (0.144)	-.140 (0.161)
X9 (p1q7ss)					.014 (0.139)	-.081 (0.160)
X10 (p1q8ss)					-.347** (0.165)	-.353* (0.185)
N	258	258	258	258	258	258
-2log likelihood	284.422	273.766	269.521	255.822	277.051	250.434
H&L Chi-square	5.685**	9.749**	17.410	10.248**	7.377**	9.583**

*p< 0.1, **p<0.05, ***p<0.001

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	P1Q9SS	-.105	.144	.531	1	.466	.900
	P1Q12	.086	.160	.287	1	.592	1.089
	Salesz	-.039	.130	.091	1	.762	.961
	P1Q3SS	.066	.187	.124	1	.725	1.068
	RDFR	**2.404**	**.845**	**8.101**	**1**	**.004**	**11.064**
	PROPENSI	.563	.515	1.195	1	.274	1.756
	P1Q4	-.099	.346	.081	1	.776	.906
	P1Q5SS	**-.386**	**.182**	**4.523**	**1**	**.033**	**.680**
	P1Q10S_1	-.119	.238	.248	1	.619	.888
	P1Q10S_2	-.253	.177	2.032	1	.154	.777
	P1Q10S_3	**-.321**	**.154**	**4.333**	**1**	**.037**	**.725**
	P1Q13	.060	.160	.142	1	.706	1.062
	P1Q11SS	**-.503**	**.182**	**7.661**	**1**	**.006**	**.604**
	P1Q6S_1	.221	.209	1.121	1	.290	1.247
	P1Q6S_2	-.140	.161	.756	1	.385	.869
	P1Q7SS	-.081	.160	.258	1	.611	.922
	P1Q8SS	**-.353**	**.185**	**3.635**	**1**	**.057**	**.702**
	Constant	7.202	2.087	11.912	1	.001	1341.606

a Variable(s) entered on step 1: P1Q9SS, P1Q12, SL, P1Q3SS, RDFR, PROPENSI, P1Q4, P1Q5SS, P1Q10S_1, P1Q10S_2, P1Q10S_3, P1Q13, P1Q11SS, P1Q6S_1, P1Q6S_2, P1Q7SS, P1Q8SS.

The values under model 1 to model 6 are the coefficients of the logistic regression for the independent variables (parentheses are standard error of each coefficients). These coefficients in the logistic regression models indicate the change in the logarithmic odds of the dependent variable when there is a change of one unit in the independent variable. A variable's positive beta coefficient indicates that the independent variable increases the odds of outcome, that is, it is inclined to carry out new technology projects through its in-house department. On the other hand, a variable's negative beta coefficient indicates its propensity to carry out the project through technology alliance. In the lower part of the first column, 'N' means the sample size used for the analysis. '-2 log likelihood' and 'Chi-square (Hosmer & Lemeshow chi-square)'[17] give statistics and test for the effects of the joint significance of the explanatory variables included in the model. 'P' below the table indicates the probabilities. The chi-square values for all the models in the table are all significant except model 3, and therefore the results of the models can be meaningfully interpreted.

The table below exhibits the estimates of fit of logistic regression models. It is the array of data for the chi-square calculations to show the correct classification percentage of the logistic regression models, model 1 to model 6. The correct classification percentages is the sum of the proportion of 'in-house development' responses that were predicted to be 'in-house' and the proportion of 'technology alliance' that was predicted to be 'technology alliance'. The correct classification percentages in these models range from 74.0 % & to 76.0 % while the 'hit rate' of a random proportional chance model is 50 %. These results indicate that all models perform better than a random proportion chance model.

(Table 39) Estimates of fit of logistic regression models

Observed		Predicted			Percentage correct
		Technology alliance	In-house	Total	
Model 1	Technology alliance	0	63	63	0
	In-house	0	195	195	100
	Total	0	258	258	**75.6**
Model 2	Technology alliance	0	63	63	0
	In-house	1	194	195	99.5
	Total	1	257	258	**75.2**
Model 3	Technology alliance	3	60	63	4.8
	In-house	2	193	195	99.0

[17] According to Quantitative Analysis in Social Research II, published by LSE, the chi-square statistics can only assumed to follow a chi-square distribution when the expected values are not too low, say greater than 5. But of course, all predicted probabilities are less than 1. As a result, the chi-square assumption is likely to be invalid. Before we can apply a chi-square, we have to apply some form of grouping. That is we group together individuals with similar values on the independent variables. This is the idea behind the Hosmer and Lemeshow test.

	Total	5	253	258	**76.0**
Model 4	Technology alliance	8	55	63	12.7
	In-house	9	186	195	95.4
	Total	17	241	258	**75.2**
Model 5	Technology alliance	0	63	63	0
	In-house	2	173	195	99.0
	Total	2	256	258	**74.8**
Model 6	Technology alliance	8	55	63	12.7
	In-house	12	183	195	93.8
	Total	20	238	258	**74.0**

Model 1 in the Table 35 is the baseline model that includes the three control variables and model. None of the coefficients of the control variables are significant. **Model 2** represents the model resulted from the five firm's internal factors perceived by the respondents. The positive coefficients for perceived level of internal capability of a firm (X_1) and the proportion of R&D workers are consistent with the hypothesis H1-1 and H1-2 supported by TC perspective. Thus, the greater the perceived level of the internal capability and proportion of the R&D workers, the more likely it is that the technology project is carried out internally. In this respect, the logic of the RB perspective, which predicted in the opposite way, is not valid in this study. However, only H1-2 is found to be statistically significant with 95 % of confidence.

The positive coefficients for previous in-house R&D experience in a relevant area (D_1) and propensity to choose specific technology-sourcing mode (routine response)(X_3) support the hypothesis H1-3 and H1-4, which are all suggested by TC, RB and INT perspective all combined; the greater these conditions are, the more likely that the technology project is carried out internally. However, none of their impacts are statistically significant. Finally, the negative coefficient for the perceived level of strategic orientation of entrepreneur (entrepreneurial orientation)(X_4) supports hypothesis H1-5 which predicts that the greater the respondents perceive themselves as entrepreneurially oriented, the more likely that the technology project is carried out through technology alliance. This result shows that dynamism has a negative and is significant with 95 % of confidence.

Model 3 represents the result of the five technology project attribute factors perceived by the respondents. The negative coefficients (X_{51}, X_{52} and X_{53}) derived from the perceived level of the specialised asset investment are consistent with hypothesis H1-6 supported by RB perspective; the logic of the TC perspective is not supported in this case. Thus, the greater the perceived level of the specialised asset investment, the more likely that the technology project will be carried out through the technology alliance. However, perceived level of the specialised intangible asset investment (X_{51}) is not statistically significant while perceived level of the tangible asset investment (X_{52})and perceived level of the redeployability of the invested assets (X_{53}) are significant with 90 % and 95 % of confidence respectively.

The RB perspective provided that as the perceived phase of the technology life cycle (X_6) reaches the mature stage, the more likely that the technology project is carried out via in-house development, which contrasts with the TC prediction. The RB perspective is supported in the analysis, however it is not statistically significant. Finally, the negative coefficient for the perceived level of the technology uncertainty (X_7) is consistent with the hypothesis H1-8 supported by MP perspective. The greater the perceived level of the technology uncertainty, the more likely that the technology project is carried out through technology alliance with 95 % confidence. In this case, the TC perspective is found to be invalid. However, the result of Model 3 cannot be meaningfully interpreted, as the model is not significant.

Model 4 represents the combined effects of the two independent factors: perceived level of the internal capability of a firm and the perceived level of the technology project attributes, compared to the impact of individual variables on the dependent variable shown in Model 2 and Model 3. Although the values of the beta coefficients are slightly changed in the model 4, the direction of the coefficient and estimated impact remains the same as the ones founded in model 2 and 3.

Model 5 presents the model resulting from the effect of the four environmental conditions perceived by the respondents. The positive coefficient for perceived level of the industrial and product market uncertainty (X_{81}) indicates that the greater the perceived level of such uncertainty, the more likely that the technology project is carried out internally. On the other hand, the negative coefficient for perceived level of the uncertainty in customer taste and competitor's action (X_{82}) indicates that the greater the perceived level of these uncertainties, the more likely that the technology project is carried out via technology alliance.

Initially, the impact of the perceived level of the environmental uncertainty on the technology-sourcing decision was conflicted with two perspectives; the TC perspective predicted positive impact while the RB/MP perspectives predicted negative impact. We found that The TC prediction is supported in terms of the X_{81}'s impact and the RB/MP perspective is supported in terms of X_{82}'s effect. So, the prediction of two divergent perspectives can be meaningfully interpreted depending on which environmental condition is considered. Unfortunately, neither of the effects is statistically significant in this study, failing to support the hypothesis H1-9 and H1-10.

The positive coefficient of the perceived level of market growth (X_9) is consistent with the prediction of RD perspective, instead of the MP perspective; the greater the level of the perceived level of market growth, the more likely that the technology project is carried out internally. However, the relationship is not statistically significant, failing to support the hypothesis H1-11. Finally, the negative coefficient for the perceived level of the legitimacy of the alliance (X_{12}) supports the hypothesis H1-12 which predicts that the greater the level of the perceived level of the legitimacy of the alliance, the more likely that the technology project is carried out through the technology alliance. This result is statistically significant with 95 % confidence, validating the logic of the IST perspective.

Finally, **Model 6** represents the combined effects of all independent and control variables on the dependent variable. Although the beta coefficient values are slightly changed, the combined impacts and their predicted directions are similar to what we have found from the previous models in the multivariable analysis using backward elimination. For instance, the impact of the X_2 is significant with 99 % confidence, and that of X_4 and X_{53} are significant with 95 % confidence. The only difference is that variable X_7 emerges as a significant impact in the holistic approach and the degree of confidence of X_{10} is lowered from 95 % to 90 %. Throughout the models, none of the control variables shows statistical significance. The following is the summary result of the hypotheses based on the combined effect of all independent variables. Tick (√) indicates identified impacts from the model testing in accordance with the predicted direction of the hypotheses. However, tick (√) with parenthesis is only significant statistically with 90-95 % confidence.

(Table 40) Summary of the hypothesis test result

	Hypotheses	**Result of the theoretical prediction**

H1-1	**(Perceived level of technological capability)** Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the Korean high-tech small firm will choose in-house development for new technology development project	TC	√
H1-1	Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the Korean high-tech small firm will choose technology alliance for new technology development project	RB, SN	
H1-2	**(Proportion of R&D workforce)** Ceteris paribus, the greater the proportion of R&D workforce, the more likely that the Korean high-tech small firm will choose in-house development for new technology development project	TC	√ (signif -icant)
H1-2	Ceteris paribus, the greater the proportion of R&D workforce, the more likely that the Korean high-tech small firm will choose technology alliance for new technology development project	RB	
H1-3	**(Previous in-house R&D experience in relevant area)** Ceteris paribus, the more previous internal R&D experience in similar area, it is more likely that the Korean high-tech small firm will choose in-house development for new technology development project	TC, RB, INT	
H1-4	**(Propensity to choose specific technology-sourcing mode (routine response))** Ceteris paribus, the more often the Korean high-tech small firm chooses in-house development for new technology development previously, the greater the likelihood that the firm will choose the same method over again	TC, RB,	√
H1-5	**(Perceived level of strategic orientation of entrepreneur (entrepreneurial orientation))** Ceteris paribus, the greater the level of the entrepreneurial strategic orientation that the Korean high-tech small firm has, the greater the likelihood that the firm will choose technology alliance for new technology development project	RB, SN	√ (signif -icant)
H1-6	**(Perceived level of specialised asset investment (technology/product specific asset))** Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the Korean high-tech small firm will choose in-house development for new technology development project	TC	
H1-6	Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the Korean high-tech small firm will choose technology alliance for new technology development project	RB	√ (signif -icant)

H1-7	**(Perceived phase of the technology life cycle (stage in technology life cycle)** Ceteris paribus, as the perceived phase of technology life cycle reach the mature stage, the Korean high-tech small firm is more likely to choose in-house development for new technology development project	RB	√
	Ceteris paribus, as the phase of technology life cycle reach the mature stage, the Korean high-tech small firm is more likely to choose technology alliance for new technology development project	TC	
H1-8	**(Perceived level of the technology uncertainty)** Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the Korean high-tech small firm will choose in-house development for new technology development project	TC	
	Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the Korean high-tech small firm will choose technology alliance for new technology development project	MP	√ (signif -icant)
H1-9	**(Perceived level of the environmental uncertainty)** Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the Korean high-tech small firm will choose in-house development for new technology development project	TC	√
	Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the high-tech small firm will choose technology alliance for new technology project	MP/ RB	√
H 1-10	**(Perceived level of the market growth)** Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the Korean high-tech small firm will choose in-house development for the new technology development project	RD	
	Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the Korean high-tech small firm will choose technology alliance for new technology development project	MP	√
H 1-11	**(Perceived level of the legitimacy of the alliance)** Ceteris paribus, the greater the perceived level of legitimacy of the alliance (pressure pushing firm to pursue cooperative strategy), the greater the likelihood that the Korean high-tech small firm will choose technology alliance for new technology development project	IST	√ (signif -icant)

(TC: transaction cost perspective; RB: resource based perspective; RD: resource dependence perspective; MP: market power perspective; IST: institutional perspective)

Discussion

The empirical data presented in this study supports its contention that technology-sourcing decision for new technology development projects is contingent on the decision-maker's perception on the firm internal and external condition and project attributes which are playing as an ex-ante mechanism. Meaningful interpretation of the estimated impact of independent variables is made next based on the complete logistic regression (Model 6).

■ The impact of a firm's perceived internal capability factors

As the hypotheses from 1-1 and 1-2 predicted, the level of the technological capability influences the firm's technology-sourcing decision. But, hypothesis 1-2 is only supported with 95% confidence. First, the firm's technological capability level relative to the industry leader is certainly one of most significant assessment criteria for technology-sourcing decision as far as the decision-makers are concerned. As Eisenhardt & Schoonhoven (1996) put it, having relevant resources (capability) to get resources (capability) is the basic condition for alliance formation. The survey reveals that the respondents do not always feel radically inferior to the industry leader regarding technological capability, meeting fundamental condition to form technology alliance. However, the analysis from the Model 6 reveals that technologically stronger respondents (measured in proportion of R&D workers) tend to choose in-house development rather than technology alliance for technology development.

Basically, in-house development can be chosen only when it allows a significant advantage over technology alliance, or vice versa. As the TC perspective argues, the advantage of the in-house development would be superior management and administrative control essential to successfully organising the project team and executing the innovative tasks while, as the RB perspective maintains, the strength of the technology alliance would allow a greater opportunity to create far more valuable technological resources, that an individual firm cannot do efficiently without outside assistance. According to the finding, we can extrapolate that the advantage of the former that TC perspective emphasised, is perceived to be more essential by the respondents in carrying out the technology project successfully. And this perception is greater when the responding firms have a sufficient internal technological capability accumulated in their internal R&D workers and top management. Thus we can conclude that firms with greater technological capabilities are better able to organise technology innovation project internally through their in-house standard procedure, operating systems and communication structure between in-house units, without incurring transaction costs with other firms for performing the same tasks.

This finding does not, however, refute the logic of the RB perspective in negative way. As it argues, a technology project should be a value-creating activity through which non-imitable strategic resources are created efficiently combining product capability and process capability successfully. Technology alliance is able to bridge them effectively and complement lacking resources, helping and learning to create strategic resources and further value potential (Sen & Egelhoff 2000). Certainly, technologically more capable firms are in a better position to achieve this goal, as they possess better in-house learning capability and rich technological portfolios. However, its argument fails to be strengthened in this research not because its logic is not inherently inferior but because it is less fitting within the context of small firm cases, compared to the logic of TC perspective.

The source of this lower fitness of the RB perspective is multifaceted. The original tenet of the RB perspective is that a firm that does not own a non-tradable asset, which it requires for implementation of competitive strategy, is restricted to building this asset through collaboration; technology cooperation allows value- creating potential at significant level only when the firms accumulated and have built sufficient internal capability (Ahuja 2000). In this sense, the benefit of the technology alliance appears to be insignificant at this stage for those small firms who are in a developing but nascent stage of development. Although the respondents subjectively perceived that they were not far behind the industry leaders in terms of technological capability, a possible scenario would be that they are optimistically over-estimating their technological capability; presumably, this is the reason why hypothesis 1-1 is not statistically supported. If this were the case, the benefit of forming technology alliance, according to the RB perspective, would be less than optimal because the respondents do not have sufficient absorptive and learning capability. Instead, they would need to make continuing efforts to accumulate further expertise and knowledge internally, in order to possess non-tradable and competitive assets internally.

Both the TC and RB perspective unanimously predict that a firm will rely on its past routine response when conducting new technological activities. Indeed, familiarity and repeated use of specific governance mode (in-house development in the case of this study) will reduce the internal management, production and transaction costs of same use (i.e., in-house development) when it is applied to other economic activities. This is widely supported in other empirical studies within the context of high-tech industry (see, Dacin, et al. 1997; Veuglers 1997; Burgel & Murray 2000). Accumulated stock of this progressive experience is a significant internal capability of a firm and will lead the firm into a history-dependent situation, in which its future actions are contrained by its previous ones. In line with this, the Model 6 exhibits a positive coefficient, as the TC and RB perspectives predicted; the responding firms tend to use in-house development as they have relied on more in-house methods for their previous projects. However, unlike in other studies, this finding is not statistically significant in this research, failing to support the hypothesis H1-4.

A tentative hypothesis can be made based on this failure. According to the descriptive statistics on page 223, about 70 % of the respondents have adopted various combinations of technology-sourcing modes instead of adhering to a particular mode excessively. This result indicates that, overall, the 75 % of respondents who have chosen in-house development did not necessarily choose internalisation simply because their history of technology-sourcing decision was in-house development. Thus, unlike the logic built up in the TC and RB perspectives, we cannot assert that the respondents' technology-sourcing decision is history-dependent or path-dependent from their previous ones, at least within the context of this study. The lack of explanatory power of the history-dependent logic is due to the fact that their strategic-making could only be history dependent only when their past strategies allows a "comfort zone" in which the decision-makers are assured by its infallible guidance and successful application, so that they do not need to scrutinise any other options. However, we can at least conjecture from this survey that the respondents do not find any generalisable "conform zone" from any technology-sourcing mode, in-house development in particular; there is not a best technology-sourcing strategy to guide the projects successfully in high-tech industry. In this sense, technology-sourcing decision cannot be really history dependent as far as newly-established HTSFs are concerned, although it may be applicable to large firms with various successful experience of innovation activities based on particular strategy.

Assisting the prediction of the RB and SN perspectives, the analysis of Model 6 supports the hypothesis H1-5 with 95 % confidence stating that the greater the level of the entrepreneurial strategic orientation that the decision-maker has, the more likely that the firm will choose technology alliance upon carrying out new technology projects. Testing this hypothesis has several implications. First, many studies have identified that the entrepreneurship of the high-tech firm's owner-manager has significantly impacted the firm's strategy-making and overall performance. However, the notion of 'entrepreneurship' is a vary vague and heterogeneous concept to define clearly, in the context of a newly-industrialised nation. The scale items used in this study correctly capture the notion by measuring the tendency of the respondents toward product innovation, risk-taking and proactiveness (Cronbach's α = 0.7710). Of course, it would be ideal to use the entire measurement scale without removing any items, however, it is not unusual for entrepreneurial strategic orientation to be altered or modified depending on the research being carried out (see Marino, et al. 2002; Dickson & Weaver 1997).

Second, there has been controversy over whether having such entrepreneur-orientation of a decision-maker is related to choosing with choosing technology alliance to some extent. Some argue that the entrepreneur should be able to obtain and gather fundamental resource ingredients quickly without relying on strategic alliance; sole ownership is a healthier alternative than co-sharing (Nuero 1999). In this sense, small entrepreneurial firms may be or should be more motivated and guided in the direction of maximising synergy and building internal resource to the maximum extent in order to meet opportunity internally. Nevertheless, this study reveals that Korean HTSFs tend to go for technology alliance when they have strong entrepreneurial strategic orientation. Entrepreneurs are people who are opportunity-driven. However, they tend to be more flexible against various risks of failure; technology alliance will insure to some extent against such risks.

Third, various empirical studies have found that HTSFs with more entrepreneurial orientation are more actively involved in networking activities through fellow business owners, friendship and kinship for the purpose of exploiting new opportunities and gathering essential resources (Borch, et al. 1999; Eisenhardt & Schoonhoven 1996). Their communication with the environment is more extensive than typical conservative firms who tend to value their independence in a way that produces a fortress-like enterprise, reluctant to engage in any behaviour which might lead to a dependence on others or even show an apparent need for others (Chell & Baines 2004). Many empirical studies identify that higher engagement in the web of networking increases the chance for the firm to form formal collaboration of all kinds (Gulati 1998, 1995). This research also supports these studies.

■ The impact of the perceived project attribute factors

Hypotheses from 1-6 to 1-8 proposed that decision-makers' perceived project factors influence their technology-sourcing decision. The analysis of Model 6 supports the hypothesis 1-6, with 95 % confidence, that the greater the perceived level of the specialised asset investment for the technology project, the more likely that Korean HTSFs will choose technology alliance.

The prediction of the RB perspective, instead of the TC one, is supported. The perceived level of the specialised asset investment is measured by tangible asset investment, intangible asset investment and overall redeployability of the invested assets. The coefficients of all three variables show negative, but the last item is only robust with statistical significance.

As previously mentioned (Chapter 4, pp.85), the technology innovation project is about creating valuable resources by investing the most valuable and specific resources existing within the firm. The TC perspective argues that it is inefficient to exchange valuable and specific resources due to the potential high costs caused by incomplete contracts and small-number bargaining hazard, while the RB perspective contends that they should be exchanged because firms are inherently limited and going it alone will be less efficient in creating further valuable resources; the firms should be looking for others' valuable resources to complement the firm itself. It further argues that trading such resources will be difficult due to imperfect mobility and imperfect imitability, so that closer interaction such as joint venture is required, which, in turn, eradicates cheating and hold-up problems between partners (Chi 1994). In fact, both arguments are irrefutable; they emphasise the risk side of transacting project-specific resources and the benefit side of value-maximising aspects of it. The present empirical study proves that the logic of RB perspective is more powerful.

Given the risks and benefits of exchanging valuable resources, the result of the analysis shows that, instead of avoiding the potential loss from exchanging firm-specific resources, the respondents appear to offset this against the benefit of exchanging valuable and invest-specific resources. Although this conclusion may be limited within this study only and requires further empirical tests, the finding may challenge typical TC views on strategy. For instance, Williamson (1991) stresses that economising is more fundamental than strategising, or, put differently, economy is the best strategy. One of the noticeable attributes of HTSFs is that they inevitably seek high-returns despite the high-risk, due to either volatility of the competitive market (high-risk and high-return market) or owner's ambition; that is why they are frequently referred to as venture firms. It appears that high-tech venture firms view strategising through technology cooperation is better course of action than cost-economising through in-house development, with respect to exploiting new market and commercial opportunity and creating further valuable strategic resources from the technology projects.

Regarding hypothesis 1-7, the Model 6 of this study represents a positive coefficient consistent with what the RB perspective predicted; ceteris paribus, the responding firms tend to use in-house development when their projects are perceived to be aiming at developing technology located in the mature stage rather than the early stage in its life cycle phase. As the RB perspective proposes, the firm may perceive great potential and opportunity in the use of technology alliance to develop technology in the early stage of the life cycle, which demands a lengthy-time span to recoup the investment, heavy financial spending and complimentary resources. Comparatively, such usefulness of technology alliance will be diminished in the latter stage of the technology life cycle where market uncertainty is largely resolved and the knowledge required is less firm-specific and idiosyncratic. As the firm in this stage can get relevant information from various sources, in-house development, acquisition or spot-market exchange is more efficient in this case. Cainarca, et al. (2000), in a study of 2,000 agreements in information technology, support this hypothesis by confirming that collaborative agreement is more prevalent during the introduction and early development stage and less prevalent during the full development and declining stages, for the reasons mentioned above.

Despite showing a positive coefficient, the Model 6 shows that the impact of the perceived phase of the technology life cycle is not statistically significant. Several assumptions for this are possible. Most of all, the prediction of the RB perspective will be valid under the assumption that the early stage of the technology life cycle of the project is characterized by great market potential and requirement for higher financial investment and complimentary resources. However, it appears that the respondents' notion of it may not necessarily match that which the RB perspective defines it to be. For instance, the survey shows that 74 % of the respondents believe that their technology projects are in a completely new, introductory and growth phase of the technology life cycle. However, the record of the respondents' previous innovation activities (see Chapter 7, pp.207) shows that, on average, 62.8 % of their innovation activities are focused on improving or modifying existing technology or knowledge assets; the innovation project may not be necessarily developing a brand new technology in the early phase of the life cycle, as far as the respondents are concerned. In this respect, the respondents may perceive the stage of the technology life cycle of incumbent projects in general terms rather than specifically reflecting the status of incumbent projects in question. We find that further refinement of measuring the technology life cycle is necessary to measure its impact correctly, and to narrow the gap between what the respondents perceive it be and what the RB perspective expects it to be.

The hypothesis 1-8 proposes that ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the

Korean high-tech small firm will choose technology alliance for new technology development projects. The Model 6 confirms it with 95 % confidence and the prediction of the MP perspective is supported. As mentioned earlier (Chapter 5, pp.135), the TC perspective argues that a number of contingencies will occur under general uncertainty, therefore, partners are likely to demand long-term contracts before committing specialised asset investment; as the number of uncertain contingency goes up, it becomes more expensive to write, monitor and enforce the contract, so that vertical integration or internalisation is more attractive (Williamson 1975). This argument is correct, but cannot be generalisable for particular uncertainty such as technology uncertainty. In the case of technology uncertainty, more technology uncertainty does not increase the number of contingencies; it only makes the few contingencies more likely. In this case, the prediction of TC perspective should be reversed.

Technology uncertainty possesses two major contingencies that firms perceive varyingly from their initiating technology projects: technical uncertainty and commercial uncertainty. These two uncertain contingencies are always in the decision-makers' minds when they are considering technology project and its sourcing decision. However, as mentioned earlier they should not defer the commitment to the new technology development until the technology has been fully proven and verified, because by then they will have lost the chance to commercialise new technology ahead of a competitor and failed to differentiate theirs from the competitor's (Folta 1998). Technology uncertainty is endogenous uncertainty and it cannot be resolved without actually undertaking the project. Given this assumption, it is better for the high-tech small firm to take early action, rather than late action, and preempt the first mover advantage in order to pre-empt the competitor; in fact, first mover advantage tends to be greatest in high-tech industries where customer switching costs are generally high (Grant 2002). To achieve this ultimate goal, technology alliance is an attractive option to the respondents instead of in-house development.

Early action, for new technology project and innovation, allows both enormous advantage as well as disadvantage to small firms. For instance, the advantage includes proprietary learning effect, preemption of inputs and development of switching costs; while the disadvantage would be free-riding problems, delayed resolution of uncertainty, shifts in technology and various types of incumbent inertia. To maximize the advantage side and secure first mover advantage, the firms must have vision, luck and proficiencies in R&D, manufacturing and marketing (Lieberman & Montgomery 1988). Technology alliance is not without limitation and the benefit of the first mover advantage will be maximised when it is achieved through internalization. However, it is less likely that the respondents will be confident of possessing all three elements essential to win the first mover advantage (vision, luck and proficiencies) internally. Therefore, technology alliance emerges as a competitive alternative to in-house development, reducing technology uncertainty and enabling the firm to proceed with the technology project, given the technology uncertainty.

■ The impact of the perceived environmental factors

Hypotheses from 1-9 to 1-11 proposed that decision-makers' perceived environmental factors do impact their technology-sourcing decision. To realise the long-term profit, they should understand not only the current condition of their firms, but also the general market conditions including anticipated changes in it and its relationship with their customers, suppliers and competitors. Three determinants were tested, and only one of them is proved to be statistically significant.

Regarding hypothesis 1-9, we found that perceived environmental uncertainty consists of two aspects: overall industrial and product market uncertainty and competitive uncertainty. The Model 6 exhibits the positive coefficient for the formal aspect of environmental uncertainty consistent with the prediction of the TC perspective in which, ceteris paribus, greater perceived level of the industrial market uncertainty leads the respondents to choose in-house development for new technology development projects. On the other hand, the model exhibits the negative coefficient for the latter aspect of environmental uncertainty supporting the MP/RD perspectives in which, ceteris paribus, greater perceived level of the competitor/customer uncertainty leads the respondents to choose technology alliance for new technology development projects. None of the predictions is significant, but the result of the analysis implies some lessons.

Although the factors related to the environmental uncertainty have been attributed with great theoretical significance and the top management must cope with such uncertainty, empirical studies do not show consistent results and recommendations on how to deal with it in technology-sourcing decision (see Chapter 5, pp..). The source of confusion giving both positive and negative effects of perceived environmental uncertainty rests on the fact that the concepts can be defined in various ways depending on the adopted theoretical bases, the research purpose and the respondents' own interpretation. In addition, there are inconsistencies in conceptualising and measuring the same construction between the researchers and respondents. This study may have such a problem. For instance, it appears that some respondents perceive it as a descriptor of the state of organisational environment while some perceive it as a descriptor of the state of himself/herself. This confusion may deteriorate the robustness of the significant test. Overly broad conceptualisation may be also causing such a problem. This study observes from the analysis that given the accelerating rate of the invention, diffusion and utilisation of new technology, perceived environmental uncertainty is getting more complex (i.e., technological uncertainty, consumer uncertainty, competitive uncertainty, competitive uncertainty, resource uncertainty, etc.). Therefore, the learned lesson is that the impact of the perceived environmental uncertainty during the course of technology-sourcing decision should be studied in relation to specific components separately, in order to attribute single individual effects properly.

As to the impact of the perceived of market growth stated in hypothesis 1-10, as the RD perspective predicts, a growing market can be characterised by munificent availability of the necessary resources such as specialised workforces in the labour market, capital investment by venture capitalists seeking new opportunity and necessary infrastructure for pooling valuable information; Easy access to them may diminish the need to form cooperation which is very often used by HTSFs as a way to source insufficient resources (Eisenhardt & Schoonhoven 1996). However, it found that the direction of the impact is opposite to this task-related and efficiency-related logic. It is assumed that a small firm's perceived elements accompanied by the market growth might differ from what the RD perspective illustrates. For instance, the respondents may not be enjoying munificent resource availability from the highly-growing market, compared to large firms. For instance, financial shortage and the difficulty of getting appropriate and qualified engineers are still chronic problems that many Korean HTSFs confront even in a growing telecommunications industry.

Contrarily, as the MP perspective maintains and negative coefficient shows, it appears that the responding firms may still need technology cooperation under munificent resource and growing market because they perceive the need for transfer of complementary technology and exchange patents, accessing local market knowledge and influencing the market structure through cooperation. These arguments have been manifested in other studies (see, Hagedoorn 1993; Narula & Hagedoorn 1999). Nevertheless, it is in question as to why the prediction of MP perspective lacks statistical support.

It is assumed that the direct impact of market growth on the technology-sourcing decision will be minimal; rather its impact may be contingent upon other key factors. For instance, Park, et al. (2002) argue in their study on the 171 US start-ups in the semiconductor industry that firms choose strategic alliance as a way to adapt to market change but it depends on the firm's resource condition and motivation. They found that resource-rich firms are more active in forming technology alliances under volatile market conditions. This logic ensures the prediction of the RB perspective. Reflecting their findings, subsequent studies may need to concern the contingent effect of market growth and volatility in technology-sourcing decision.

Lastly, regarding hypothesis 1-11, the Model 6 of the analysis demonstrates a negative coefficient consistent with what the IST perspective predicted; Ceteris paribus, the greater the perceived level of legitimacy of the alliance (pressure pushing the firm to pursue cooperative strategy), the greater the likelihood that the Korean HTSF will choose technology alliance for new technology development projects. This is supported with 90 % confidence. This hypothesis intends to measure the possible impact of legitimacy or mimetic behaviour of the respondents for technology alliance. Although some studies have previously focused on such issues based on foreign market entry decision within the context of large firms in developing nations (Haveman 1993), this is the first attempt to assess presumed impact specifically focused on technology-sourcing decision within the contest of high-tech start-ups in newly-industrialised countries.

Dimaggio and Powell (1983) have argued that what is surprising about organisations is not their diversity, but their similarity, by referring to 'mimetic isormorphism' which is the process of organisations imitating others that are perceived to be legitimate and successful. Indeed, as they put (1983, p.151), "when organisational technologies are poorly understood, when goals are ambiguous, or when the environment creates symbolic uncertainty, organisations may model themselves on other organisations". Although their logic tends to reflect the similarity of firms' behaviour in scanning their environment, it is found that it can still be applicable to this study's concern. However, a context specific to Korea should be addressed to explain why respondents follow or are led by mimetic isomorphism favourable to technology alliance.

In Korea, the size and diversity of society tend to be small and homogenous, and plurarity of institutional structures tends to be integrative, compared to other large nations. Hofstede (1980) argued that Korean culture is characterised by relatively lower individualism, relatively higher power distance within the hierarchy, stronger uncertainty avoidance and lower masculinity, and these elements have created the conditions that allowed a single individual to spread a common model of, at least, a formal scanning system of environment. In business terms, this leads a small set of powerful and successful individuals (i.e., large Korean conglomerates) to play the dominant and leading role in business practice and strategy, causing imitative behaviour of followers (not only large firms but also small firms) in the rapidly changing and competitive environment (Ghoshal 1988).

After the late 1990s and through the financial crisis in East Asia, one important and pervasive change of business strategy initiated by a few large Korean conglomerates and vindicated by academia has been globalisation, downsizing, outsourcing and strategic alliance, in order to leap forward to the status of world-class companies. As a result, some conglomerates such as *Samsung* and *LG* and high-tech start-ups such as *Mirae* and *Turbotek* have been able to achieve global leadership in their respective business fields. In fact, these firms are key players in Korean telecommunications industry in terms of innovation and respective market share. It is highly likely that their practices have been influential to other high-tech followers who imitate them, regarding their successful strategies as a crucial benchmark, and are influenced by them when they require a transition and need to see the way forward.

However, further research remains to be done in this area, including how the respondents are assessing the best practice, who the key informants are, and what the scanning method is, if mimetic adoption of technology alliance has a statistically significant impact. Therefore, the finding of this research calls for further theoretical development and empirical examination to shed light on how and why these processes occur.

Chapter 9: Determinant of structuring technology alliance in stage two (hypotheses testing)

This chapter will examine the determinants of structuring technology cooperation for 63 respondents who chose technology alliance in the first stage of technology-sourcing decision. The objective of this chapter is to understand and predict the likelihood that Korean HTSFs will select a particular decision. Previously, this study proposed that four major determinants are significant in the second stage of the contingency model: perceived level of the appropriation regime, perceived scope and scale of the technology development project, perceived trust level with the potential partners and perceived technological capability gap with the potential partner. The next sections will examine their impact on the second stage of the contingency model. As in the previous chapter, multivariate analysis, logistic regression analysis in particular, will be applied to interpret the determinants' impact simultaneously. Before doing that, it is necessary to identify the fundamental attributes of the respondents' technology alliance.

9.1 Characteristics of the respondents' technology alliance

This study attempted to investigate several key issues related to the technology alliance. These include the total amount of budget invested, specification of the technology being developed, project name, present status of the project, estimated time span for completion, importantly, partner name and how long the relationship with the partner, if any, has existed. However, many respondents refused to provide such information, thus only a few of them are presented here.

Relative size of the partner

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Much smaller	6	9.5	9.5	9.5
	Slightly smaller	3	4.8	4.8	14.3
	About the same	5	7.9	7.9	22.2
	Slightly bigger	10	15.9	15.9	38.1
	Much bigger	22	34.9	34.9	73.0
	No-comment	17	27.0	27.0	100.0
	Total	63	100.0	100.0	

The Korean HTSFs chose various sizes of partners. But 50.8 % of the respondents chose larger firms as their partner.

Partner type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Supplying firm	17	27.0	27.0	27.0
	Customer firm	11	17.5	17.5	44.4
	Competitor	7	11.1	11.1	55.6
	Firm in non-related industry	1	1.6	1.6	57.1
	Public or governmental research institute	5	7.9	7.9	65.1
	Universities	3	4.8	4.8	69.8
	etc.	3	4.8	4.8	74.6
	No-comment	16	25.4	25.4	100.0
	Total	63	100.0	100.0	

Because the sample size is small and 16 firms refused to reveal their partners, it is difficult to determine which is the key alliance partner type of the Korean HTSFs. Literature shows that supplying and customer firms in the value chain of the industry activities are likely to become the most frequent alliance partners (Narula 2004). The results of the survey also reveal similar findings. Perhaps these firms related in upstream or downstream activities may share some homogeneity acting through shared belief and close interaction. This reduces the transaction costs by avoiding misunderstanding, and, at the same time, integrity and loyalty underpins the willingness to share knowledge. In addition, firms tend to receive the most valuable information from their customer or supplier, as they are closely linked vertically. Therefore, firms are frequently choosing supplying or customer firms as alliance partners.

The respondents are not necessarily partnering with previously related customers, suppliers, institutions or competitors.

Previous relationship with the partner

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	19	30.2	30.2	30.2
	No	38	60.3	60.3	90.5
	No-comment	6	9.5	9.5	100.0
	Total	63	100.0	100.0	

Even though 9.5 % of the respondents did not reply, more than 60 % have said that they are partnering with previously non-related firms or institutes. This is quite a contrast to the previous findings of several published studies, which stressed that previous relationship and familiarity plays the significant role in deciding who will be the partner (Gulati 1995; Larson 1992). In contrast to them, this study finds that Korean HTSFs are not necessarily restricted to their previously business-related or experienced firms when they are considering appropriate technology alliance partners. Probably, many short-time established small firms are not likely to have many previous related firms.

According to the TC perspective, forming alliance with previously unrelated firms contains more disadvantage than advantage (Madhok 1994). For instance due to increased fear of opportunistic behaviour by the new partner, the quality of interaction will diminish and the cost of maintaining safeguards will be high. This contention is not valid in this research finding. As Granovetter (1973) mentioned, society is a loosely-coupled and personalised system entangled in multiple networks; so too is the Korean telecommunications industry. The Korean HTSFs will be able to channel the information about the potential partner and their known reputation from their social network. In addition, it is possible that the firm and its potential partner may hold a third party in common in the quiet narrowly-defined Korean market. The third party may play the role of a trusted informant to each potential partner about the other, providing details of past dealings. Combining all these possibilities, joining new partner without a previous relationship does not impose much difficulty. In this sense, partnering with a previously unrelated or non-interdependent firm will be more common in the high-tech industry. The mutual need for the partner's resource makes shared ownership more conducive for encouraging participation even if they have not worked together previously.

In conclusion, this study argues that a firm would be better off without the operating assumption of opportunism and, consequently, by not investing in excessive levels of protection against the probable opportunists in all interactions. This policy may result in occasional loss, but on average, due to lower safeguarding costs and the synergistic gains from a mutually cooperative orientation, it will be better off in the long term. In other words, the overall expected loss from opportunistic behaviour would be less than the overall expected gains from the cooperative interaction. Therefore, unlike the warning of the opportunism-based perspective, choosing a completely new partner is not always a poor decision.

As noted previously, a technology alliance is formed for multiple reasons. The 63 respondents are no exception. Based on the literature consulted, this study developed eleven major technology alliance motivations. Using five point-Likert Scale in which 1 is denotes 'not at all important', 2 denotes 'not so important', 3 denotes 'neutral', 4 denotes 'fairly important' and 5 denoting 'very important', the respondents were asked to rate underlying motivations of their technology alliance by the level of their significance.

Cronbach's alpha is used to examine the reliability of the measurement.

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Reliability Coefficients
N of Cases =     63.0                 N of Items = 11
Alpha =    .9508
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The Cronbach's alpha value is 0.9508, which indicates very good and acceptable measurement of the concept.

The following table ranks the various motivations for technology alliance by the perceived level of its significance to the projects.

Descriptive Statistics by technology alliance motivation (by significance ranking)

Ranking	N	Minimum	Maximum	Mean	Std. Deviation	Variance
1. P1Q6_8	63	1	5	4.83	1.326	1.759
2. P1Q6_7	63	1	5	4.71	1.591	2.530
3. P1Q6_5	63	1	5	4.67	1.191	1.419
4. P1Q6_4	63	1	5	4.62	1.288	1.659
5. P1Q6_11	63	2	5	4.57	1.201	1.442
6. P1Q6_6	63	1	5	4.41	1.433	2.053
7. P1Q6_3	63	1	5	4.37	1.286	1.655
8. P1Q6_2	63	2	5	4.21	1.152	1.328
9. P1Q6_9	63	1	5	4.14	1.378	1.899
10. P1Q6_10	63	1	5	3.54	1.803	3.252
11. P1Q6_1	63	1	5	3.48	1.512	2.286
Valid N (listwise)	63					

P1q6_1: Accessing external complimentary resources and capabilities and to better exploit resources
P1q6_2: Reducing transaction costs
P1q6_3: Reducing production/R&D costs and sharing uncertain risk
P1q6_4: Internationalisation, globalisation and foreign market entry
P1q6_5: Increasing efficiency, synergy and creating dominant power through network formation
P1q6_6: Broadening the effective scope and scale of activities
P1q6_7: Creating new investment opportunity in high-return and high-risk area
P1q6_8: Pre-empting the market over competitors and improving strategic position
P1q6_9: Promoting organizational learning/knowledge spill-over and internalizing the core competencies
P1q6_10: Receiving government funding and technological assistance
P1q6_11: increasing information sharing and expanding knowledge uses

The respondents perceive that pre-empting the market ahead of competitors and improving strategic position (p1q6_8) is the most important motivation for their technology alliance, followed by the need to create investment opportunity in high-risk and high-return areas (p1q6_7). Stressing the limitation of the resources of small firms, many literatures argues that minimising or reducing the cost of the project, and, at the same time, accessing complimentary resources and capability used to be the major alliance motivation of small firms (Dodgson & Rothwell 1991; Forrest 1990). However, the survey of this study found that Korean HTSFs are more motivated by the competitive strategic issues rather than reducing various financial burden and project costs when they form technology alliance.

Alliance formation motivated by hopes of improving strategic position, shown above, makes important implications about what Korean HTSFs intend to achieve from the technology cooperation. It is argued that small firms possess advantages of compactness over large firms: the ability to respond quickly and flexibly to rapid changes in high-tech industry (Gomes-Casseres 1997). However, the disadvantage of small size is that the small firms can only focus on small-segmented markets due to their focused but limited resource and capability profile. Small-segmented markets may present even more competitive pressure from various domestic and international firms, especially so if there is high-risk and high-return potential. Therefore, the small firms should follow a deterrence strategy in a niche market in order to block other incumbents from embarking on an aggressive counteraction against their entry into the market. Technology alliance helps to achieve such goals. It blocks the competition by raising the scale of resources and sunk costs devoted to the project and by enlisting a partner with specific skills, so that competitors cannot gain access to it. Signing an agreement with an attractive partner is also signalling the small firm's commitment to maintaining a credible presence in the market.

Many respondents did not disclose the details of alliance project they were undergoing and the data collected is not sufficiently large. Thus, concrete understanding of the Korean HTSFs' technology alliance would still be elusive from the findings thus far. Nevertheless, significant insight can be drawn from the survey. For instance, choosing a partner grows complex as the role of the Korean HTSFs are no longer limited to providing OEM or peripheral products to the large conglomerates, as a subordinated supplier. Apparently, the objective of the alliance is multidimensional, but strategy-driven motivation becomes the most significant reason. To meet the respondents' various strategic objectives, partners should not necessarily be limited to a certain size and a certain type. In addition, technology alliance with many forms of partnership and combinations can be aggregated to a dichotomy of equity- and non-equity technology alliance as basic modes into which the respondents are divided. However, recommending most suitable alliance mode to realise complex and strategy-driven motivations will be difficult, if not impossible. The next section intends to contribute to this part by considering how five determinant conditions would influence the selection of the best-suited alliance mode for each respondent.

9.2 Descriptive analysis on the choice of technology alliance structure

Very similar analytic logic can be applied in this section as seen in earlier Chapter 8. Prior to analysing the impact of the four main attributes on the structure of the technology alliance, let us see how the 63 respondents are divided in their choices between equity alliance and non-equity alliance.

Mode of technology alliance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Equity alliance	26	41.3	41.3	41.3
	Non-equity alliance	37	58.7	58.7	100.0
	Total	63	100.0	100.0	

According to the table above, 41.3 % of the 63 responding firms have chosen equity alliance while 58.7 % of them have chosen non-equity alliance for new technology development. As expected and noted in the previous chapter, more Korean HTSFs are choosing non-equity alliance rather than equity alliance as a favourable governance structure of their technology alliance.

Two reasons can be presented for this. First, the respondents' technology projects tend to be domestic and locally-based one with domestic partners. As the project is not on a global or international basis, some level of harmonisation in the legal and administrative framework between each local partner may not be necessary. Rather, such technology project needs to have quick response to the local demand change based on readily enforceable contract such as non-equity based technology cooperation. Despite this assumption, 41.3 % of the respondents chose equity-based alliance. Prior to investigating underlying factor deciding such division of technology alliance modes, the next section will concern the measurement of goodness and descriptive characteristics of the four major determinants based on the respondents' reaction to the questions asked, and their hypothesized impacts on the structuring technology alliance.

■ Measurement of goodness and descriptive analysis

Perceived level of the appropriation regime

Five items were used for measuring the perceived level of the appropriation regime of the technology project. Cronbach's alpha and factor analysis are used for examining the reliability and validity of the measurement, as seen in the table below.

Reliability test

```
Reliability Coefficients
N of Cases =      63.0                     N of Items = 5
Alpha =     .5364
```

The Cronbach's alpha value for the measurement of the five items is 0.05364. However, as seen in the table, excluding p2q9_1 much improves the reliability of the measurement for the concept.

Reliability test

```
Reliability Coefficients
N of Cases =      63.0
N of Items =  4 (p2q9_2, p2q9_3, p2q9_4, p2q4_5)
Alpha =     .6671
```

The Cronbach's alpha value 0.6671 can be considered good and acceptable for the analysis. Therefore, the four items will be used for the validity test of the measurement.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.026	50.644	50.644	2.026	50.644	50.644	1.602	40.060	40.060
2	1.144	28.591	79.235	1.144	28.591	79.235	1.567	39.175	79.235
3	.554	13.841	93.076						
4	.277	6.924	100.000						

Extraction Method: Principal Component Analysis.

According to the table above, four measurement items consist of two components as they have Eigenvalues greater than 1. Factor 1(component 1) can explain 50.644 % of the total variance of the four variables and factor (component 2) can explain 28.591 % of the total variance. Together, they have strong explanatory power as they can explain 79.235 % of the four variable items.

Variable	Item (item name)	Factor loading (factor 1)	Factor loading (factor 2)	Cronbach's alpha
Perceived level of	The intellectual property of our firm is likely to be tacit and uncodifiable in nature (p2q9_2)	**.894**	-.032	0.6671

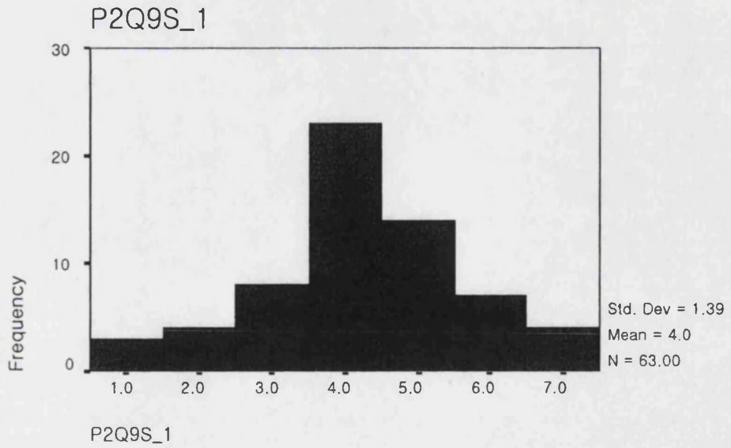
the appropriation regime	It was difficult to state clearly the amount of knowledge exchanged with the cooperating partner (p2q9_4)	**.849**	.300	
	Misappropriation activity would be more likely to occur once the cooperation with the partner is related (p2q9_3)	-.027	**.879**	
	Dispute regarding technological leakage or free-riding are common in the industry (p2q9_5)	.284	**.839**	

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

As seen in the table, the Factor 1 is explained well by variable items p2q9_4 and p2q9_2 (in order of their significance to factor 1) whose factor loading is larger than 0.4, while factor 2 is explained well by item p2q9_3 and p2q9_5 (in order of their significance to Factor 2). Factor 1 represents a potential source of appropriation problems with the partner that may be caused by the variation of the codifiability and explictness of the knowledge exchanged (boundary of the knowledge exchanged). Factor 2 represents a potential source of appropriation problems caused by the partner's intentional free-ride attempts and unwilling technology spillover. As predicted in the literature review in Chapter 5, two factors are found to be significant components of the partners' perceived level of the appropriation regime. For the convenience of the analysis, Factor 1 is referred to as p2q9s_1 and Factor 2 as p2q9s_2 which will be used as individual variables in the full model to be tested. The Followings are the descriptive analyses of each factor.

Descriptive Statistics for p2q9s_1 (perceived level of the appropriation regime influenced by codifiability and explicitness of the knowledge exchanged)

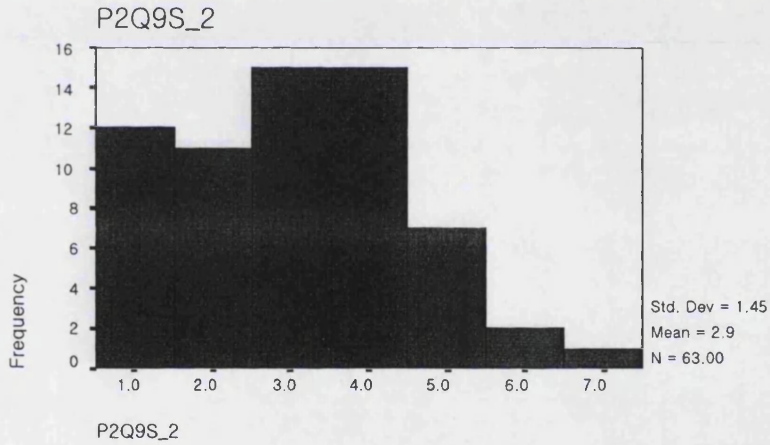
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
P2Q9S_1	63	1.000	7.000	4.01587	1.391125	1.935
Valid N (listwise)	63					



On average, the respondents perceive that their appropriation regime from the technology cooperative projects is not deteriorated or improved by the level of the codifiability and explictness of the knowledge exchanged (the mean score is 4.0 with 1.39 of standard deviation). Specifically, 38.1 % of the respondents disagreed that the level of the codifiability and explicitness of the knowledge exchange would affect the appropriation regime in their technological cooperative projects. 22.2 % of them posed neutral and 39.7 % of them agreed that such level would affect the appropriation regime in their cooperative projects to some extent.

Descriptive Statistics for p2q9s_2 (perceived level of the appropriation regime influenced by the potential partner's free-riding and technology spillover)

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
P2Q9S_2	63	1.000	7.000	2.87302	1.447936	2.097
Valid N (listwise)	63					



On the other hand, the respondents perceived that their appropriation regime from the technological cooperative project would never be influenced by the partner's free-riding attempt or unwilling knowledge spillovers (the mean score is 2.9 with 1.45 standard deviation). According to the histogram, 71.4 % of the respondents disagreed that a partner's free-riding attempt or unwilling knowledge spillover issue would deteriorate their appropriation regime from the cooperative project, 12.7 % posed a neutral and only 15.9 % of them agreed that such a threat might affect their appropriation regime to some extent. In summary of the findings above, the respondents perceived that the proactiveness of the knowledge exchanged would not seriously affect their appropriation regime. It is assumed that such findings may result from the fact that the respondents are likely to be recipients of the partners' knowledge, thus, maintaining suitable appropriation regime may not be a critical issue among many respondents.

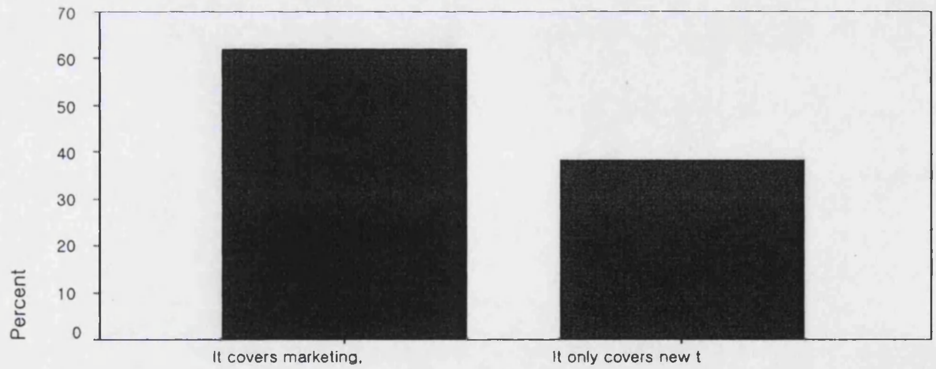
Perceived scope and scale of the technology development project

Both the scope and scale of technology alliance reflect its complexity. The scope of technology alliance indicates to what extent the cooperative activity covers along the vertical value chain of the technology project. The new technology/product should be marketable and contribute to the profit of the Korean HTSFs. In this respect, the new technology alliance project is likely to include sales, distribution and marketing, as well as research and development.

The scope of technology alliance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	It covers marketing, distribution & sales as well	39	61.9	61.9	61.9
	It only covers new technology/product development	24	38.1	38.1	100.0
	Total	63	100.0	100.0	

The scope of technology alliance

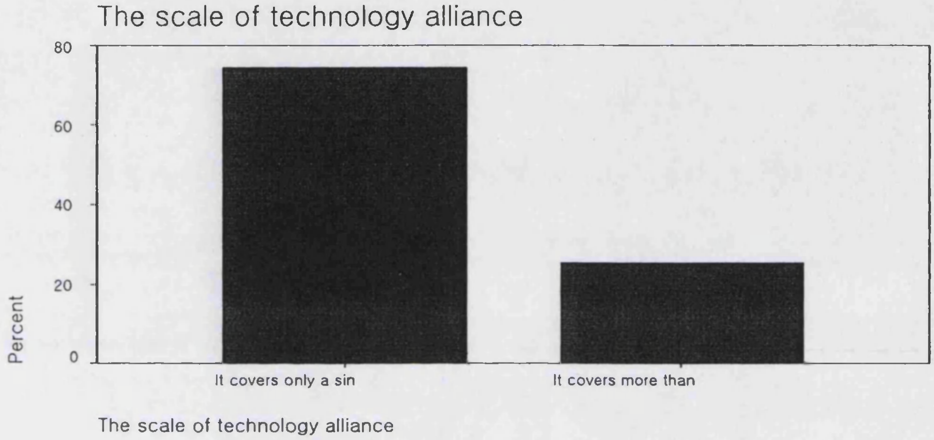


The scope of technology alliance

61.9 % of the respondents say that their technology alliance covers a wider scope of activities not only limited to the R&D, but also including marketing, sales, and distribution, implying that their technology alliance tends to be complex. 38.1 % of the respondents say that their technology alliance is only concentrated on R&D.

The scale of technology alliance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	It covers only a single technology/product	47	74.6	74.6	74.6
	It covers more than two technology/product	16	25.4	25.4	100.0
	Total	63	100.0	100.0	



A firm may initiate the alliance project aiming at broader area of technologies with more than two technology developments. This type of alliance project is quite often in high-tech industries as knowledge resources required are highly related from various areas. The survey shows that, however, dominant respondents (74.6 %) are rather focused on a single technology/product and only 16 % of respondents say that their alliance project are covering wider scope of technology with more than two new products. This implies that dominant Korean HTSFs would like to focus on single technology per single project as it is more efficient at specialisation and less risky.

Perceived trust level with the potential partner

Eight items were used for measuring perceived trust level with the potential partner.

The Reliability test

```
Reliability Coefficients
N of Cases =      63.0                    N of Items =  8
Alpha =    .8156
```

The Cronbach's alpha value is 0.8156 which implies that the reliability of the measurement is very strong. However, as we see in the table below, the reliability is improved without the question items p2q9_4.

The Reliability test

```
Reliability Coefficients
N of Cases =     63.0
N of Items =  7 (p2q8_1, p2q8_2, p2q8_3, p2q8_5, p2q8_6, p2q8_7, p2q8_8)
Alpha =     .8522
```

Without item p2q9_4, Cronbach's alpha for the seven items measured is 0.8522. The internal consistency and reliability of these measurements are improved from the previous measurement and can be considered quite good. Thus, seven items are used for the validity test of the measurement.

The validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.796	54.228	54.228	3.796	54.228	54.228	3.289	46.983	46.983
2	1.075	15.358	69.585	1.075	15.358	69.585	1.582	22.602	69.585
3	.708	10.120	79.706						
4	.588	8.405	88.110						
5	.362	5.170	93.281						
6	.285	4.073	97.353						
7	.185	2.647	100.000						

Extraction Method: Principal Component Analysis.

The result of the validity test shows that two factors have an Eigenvalue greater than 1. As predicted earlier, the perceived trust level can be measured by two dimensions and they as a set represent the concept of interest. Factor 1 (component 1) can explain 54.228 % of the total variation of the seven measurement items. Factor 2 (component 2) can explain 15.358 % of the total variation of the seven items respectively. The two factors together can explain 69.585 % of the variation of the seven items. The two components represent strong explanatory power and validity of the seven items measured. The following is the summary of the reliability and validity test.

Variable	Items (item name)	Factor loading (factor 1)	Factor loading (factor 2)	Cronbach's alpha
The perceive	We thought that our partner firm could be trusted to make sensible decisions for the future of the alliance (P2q8_2)	**.823**	.217	0.8522

d trust level with the potentia l partner	We thought that our partner would lend us a helping hand if we run into problems (P2q8_6)	**.816**	.367	
	We thought that our partner has the skills and qualifications for the job (P2q8_8)	**.814**	.176	
	We thought that our partner would not put us in danger due to negligence and carelessness on the job (P2q8_7)	**.806**	.204	
	We thought that our partner was an economically and socially efficient organization (P2q8_3)	**.749**	.008	
	We thought that partner firms were sincere in this attempt to meet our point of view (P2q8_1)	.082	**.866**	
	We thought that our partner could be relied upon to keep the promises (P2q8_5)	.259	**.760**	

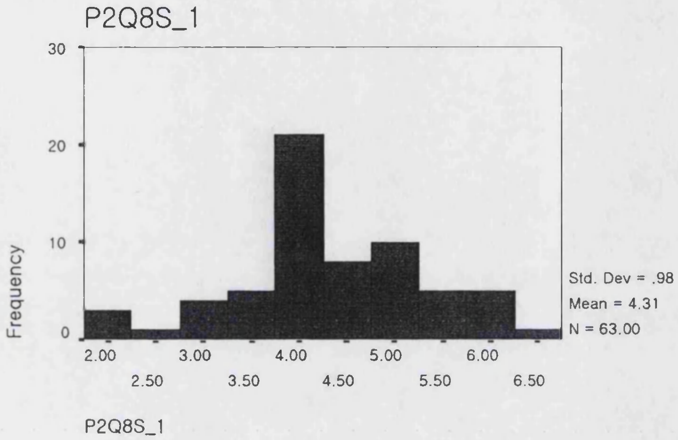
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

As seen above, the perceived trust level with a potential partner can be represented by two factors. Factor 1 is explained by the measurement item p2q8_2, p2q8_6, p2q8_8, P2q8_7 and p2q8_3 (in order of significance to the factor 1), whose factor loading is larger than 0.4. Factor 2 is explained by the measurement item p2q8_1 and p2q8_5. Earlier, in Chapter 5, this study suggested two aspects of trust between potential partners: goodwill and forbearance trust and competence trust. Factor 1 reflects the competence aspect of the trust in that it concerns the expectation that a partner will perform his role competently with devotion and faithfulness while Factor 2 reflects goodwill and forbearance trust in that it concerns a mutual expectation of open commitment to each other. For the convenience of the analysis, Factor 1 is named as p2q8s_1 and Factor 2 as p2q8s_2. The followings are descriptive analyses of both factors.

Descriptive Statistics p2q8s_1 (perceived trust level in terms of competence aspect)

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
P2Q8S_1	63	2.000	6.400	4.31429	.977630	.956
Valid N (listwise)	63					

The respondents revealed varying ranges of perceived level, from no trust (2.0) to highly trust (6.4). On average, the respondents neither strongly distrusted nor strongly trusted their partners in their competence of performance for the cooperative project (the mean value is 4.31 with 0.977 standard deviation).



The histogram above shows that 27.0 % of the respondents assumed that their partners would not perform competently, 17.5 % of them took a neutral position on this issue and 55.6 % of them believed that their partners would be likely to perform competitively for the cooperative projects.

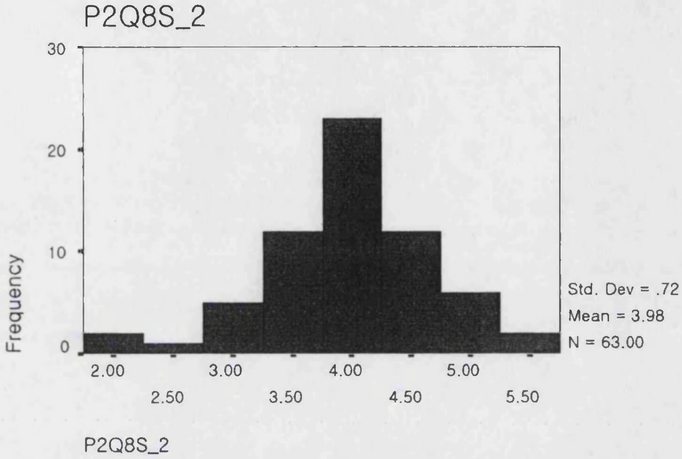
Descriptive Statistics p2q8s_2(perceived trust level in terms of goodwill/forbearance aspect)

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
P2Q8S_2	63	2.000	5.500	3.97619	.715207	.512
Valid N (listwise)	63					

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
P2Q8S_2	63	2.000	5.500	3.97619	.715207	.512
Valid N (listwise)	63					

Similarly, the respondent took a neutral position on their perceived trust level with the partners in terms of their goodwill/forbearance for the cooperative project (the means score is 3.976 with 0.715 standard deviation).



Specifically, the histogram shows that 31.7 % of the respondents did not believe that their partners would display goodwill and forbearance for the cooperative project, 36.5 % of them posed a neutral position for this issue and 31.7 % of them believed that their partners would display goodwill and forbearance for the cooperative projects. Considering p2q9_1 and p2q9_2 together, it is interesting to note that more than one third of the respondents cast doubt on their partners' competent performance and their forbearance which are essential elements in executing cooperative projects successfully. It would be, therefore, interesting to investigate the role of trust in structuring technology alliance: how to deal with less trustworthy partners

Perceived technological capability gap with the potential partner

Seven items were used for measuring the perceived level of the technological capability gap with the potential partner.

The Reliability test

```
Reliability Coefficients
N of Cases =     63.0                    N of Items =  7
Alpha =    .9579
```

Cronbach's alpha value for the seven items is 0.9579. The internal consistency and reliability of the measurement used are very strong.

Validity test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.602	80.027	80.027	5.602	80.027	80.027

2	.502	7.170	87.198			
3	.313	4.478	91.676			
4	.216	3.092	94.767			
5	.199	2.845	97.612			
6	.095	1.360	98.972			
7	.072	1.028	100.000			

Extraction Method: Principal Component Analysis.

The validity test shows there is only one factor having an Eigenvalue greater than 1. The perceived level of the capability gap is measured by only one factor which explains 80.027 % of the variation of the seven items. The validity of the seven items is very strong. The following is a summary of the reliability and validity test.

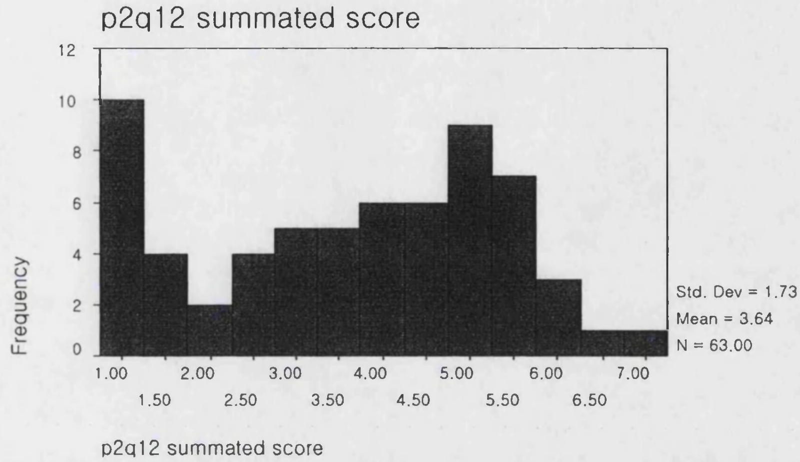
Variable	Item (item name)	Factor loading (factor 1)	Cronbach's alpha
Perceived level of the technological gap with the potential partner	Modifying related technology (P2q12_2)	.931	0.9579
	R&D workforces capability (P2q12_3)	.919	
	R&D facilities (P2q12_4)	.913	
	Ability to collecting related technological information (P2q12_5)	.907	
	Developing core technology (P2q12_1)	.882	
	Ability to absorb knowledge transferred or transmitted (P2q12_6)	.870	
	Utilising technological advisory group (P2q12_7)	.837	

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

The respondents tend to form technology alliances with technologically-superior firms. On average, they perceive that they are slightly inferior to the potential partner in terms of technological capability (average score is 3.644), but the technological capability gap with the partner is wide varying, as summarised in the table below.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
p2q12 summated score	63	6.0	1.0	7.0	3.644	1.7337	3.006
Valid N (listwise)	63						



According to the histogram, 49.2 % of the respondents perceive that they are technologically less capable than the potential partners while 46 % perceive that they are technologically equal or better positioned than the potential partners.

9.3. Holistic approach to the choice of technology alliance structure

The following is a summary of the hypotheses and measurement of the five variables assumed to be influential to the modal choice of technology alliance.

Variable	Variable name	Description (measurement and hypotheses)
logit^	P2q2	(0 = equity technology alliance, 1=non-equity technology alliance)
X_{11}	P2q9ss	Perceived level of the appropriation regime (5 items. 7 scale)
		H1-12: Ceteris paribus, the weaker the perceived level of intellectual property regime (appropriation regime), the greater the likelihood that the decision-makers of Korean high-tech small firm will choose equity alliance for new technology development project
D_2	P2q10	Perceived scope of the technology development project •0= If the alliance activity covers only R&D •1= If the alliance activity covers not limited to R&D but also production, marketing and supplying activity

		H1-13 *:Ceteris paribus, the broader the perceived level of scope of cooperative activity (not only including R&D activities but also manufacturing, marketing and/or supply activities as well), the greater the likelihood that the decision-makers of Korean high-tech small firm will choose an equity alliance for new technology development project*
D_3	P2q11	Perceived scale of the technology development project • 0= If the alliance activity covers only one type of technology/product • 1= if the alliance activity covers more than two types of technology/product
		H1-14: *Ceteris paribus, the broader the perceived level of the scale of cooperative activity (not only limited one technology but also covering range of products/technologies), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project*
X_{12}	P2q8ss	Perceived trust level of the potential partner (8 items, 7 scale)
		H1-15: *Ceteris paribus, the stronger the perceived level of trust with the potential partner, the greater the likelihood that decision-makers of Korean high-tech small firms will choose non-equity alliance for new technology development project*
X_{13}	P2q12ss	Perceived level of the technological capability gap with the potential partner (7 items, 7 scale)
		H1-16; *Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an non-equity alliance for new technology development project.* *Or* *H1-16;* *Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project.*

Using the logistic regression from the variables above, the following equation model can be made, in which structuring technology alliance is a function of the following five determinants.

$$\text{Logit}^\wedge = \alpha - \beta_{11}X_{11} - \beta_2 D_2 - \beta_3 D_3 + \beta_{12}X_{12} \pm \beta_{13}X_{13}$$

(**X11:** P2q9ss, **D2:** P2q10, **D3:** P2q11, **X12:** P2q8ss, **X13:** P2q12ss)

However, as we found from the validity and reliability tests, variables **X_{11}** (p2q9ss) and X_{12} (p2q8ss) have two unique dimensions within them respectively. So, **X_{11}** (p2q9ss) is divided into **X_{111}** (p2q9s_1) and **X_{112}** (p2q9s_2) and **X_{12}** (p2q8ss) is divided into **X_{121}** (p2q8s_1) and **X_{122}** (p2q8s_2). Using them as individual variables, we can re-write the full model of the logistic equation as:

$$\text{Logit}^{\wedge} = \alpha - \beta_{111}X_{111} - \beta_{112}X_{112} - \beta_2 D_2 - \beta_3 D_3 + \beta_{121}X_{121} + \beta_{122}X_{122} \pm \beta_{13}X_{13}$$

(**X111:** P2q9s_1, **X112:** P2q9s_2, **D2:** P2q10, **D3:** P2q11, **X121:** P2q8s_1, **X122:** P2q8s_2, **X13:** P2q12ss)

The ^(hat) indicates the predicted value. The predicted directions (signs) of the coefficient β_{13} has not been determined yet due to conflicting theoretical predictions, which will be tested in the next section. α is an intercept term.

As a first step, the Pearson-correlation test is adopted to assess the Multicollinearity problem.

Correlations

		P2Q9S_1	P2Q9S_2	P2Q10	P2Q11	P2Q8S_1	P2Q8S_2	p2q12SS
P2Q9S_1	Pearson Correlation	1	.299(*)	.086	-.178	.326(**)	.244	.387(**)
	Sig. (2-tailed)	.	.017	.504	.162	.009	.054	.002
	N	63	63	63	63	63	63	63
P2Q9S_2	Pearson Correlation	.299(*)	1	.092	.039	-.142	-.124	-.069
	Sig. (2-tailed)	.017	.	.473	.762	.266	.334	.589
	N	63	63	63	63	63	63	63
P2Q10	Pearson Correlation	-.086	-.092	1	.082	-.325(**)	-.211	-.439(**)
	Sig. (2-tailed)	.504	.473	.	.522	.009	.098	.000
	N	63	63	63	63	63	63	63
P2Q11	Pearson Correlation	-.178	.039	.082	1	.006	.045	-.041
	Sig. (2-tailed)	.162	.762	.522	.	.960	.725	.751

	N	63	63	63	63	63	63	63
P2Q8S_1	Pearson Correlation	.326(**)	-.142	-.325(**)	.006	1	.421(**)	.589(**)
	Sig. (2-tailed)	.009	.266	.009	.960	.	.001	.000
	N	63	63	63	63	63	63	63
P2Q8S_2	Pearson Correlation	.244	-.124	-.211	.045	.421(**)	1	.282(*)
	Sig. (2-tailed)	.054	.334	.098	.725	.001	.	.025
	N	63	63	63	63	63	63	63
p2q12SS	Pearson Correlation	.387(**)	-.069	-.439(**)	-.041	.589(**)	.282(*)	1
	Sig. (2-tailed)	.002	.589	.000	.751	.000	.025	.
	N	63	63	63	63	63	63	63

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

P2Q9S_1: perceived level of the appropriation regime (influenced by codifiability and explicitness of the knowledge exchanged)
P2Q9S_2: perceived level of the appropriation regime (influenced by partner's free-riding attempt or unwilling knowledge spillover)
Scope: perceived level of the scope of the technology development project
Scale: perceived level of the scale of the technology development project
P2Q8S_1: perceived trust level with the potential partner (in terms of competence aspect)
P2Q8S_2: perceived trust level with the potential partner (in terms of goodwill and forbearance)
P2Q12ss: perceived technological capability gap with the potential partner

Bivariate Peason correlation table shows that all variables are related to some extent. In particular, the variable p2q8s_1 does have a moderate relationship with variable p2q12ss (r=0.589) at $\alpha = 0.01$ level. Apart from this, the correlation matrix do not show any severe multicollinearity problem as their relations are all less than 0.5.

Finally, a total of eight variables in association with control variables will be tested against the research question using the following full model.

$$Logit\hat{} = \alpha - \beta_{111}X_{111} - \beta_{112}X_{112} - \beta_2 D_2 - \beta_3 D_3 + \beta_{121}X_{121} + \beta_{122}X_{122} \pm \beta_{13}X_{13} \pm \beta_{14}X_{14} \pm \beta_{15}X_{15} \pm \beta_{16}X_{16}$$

(**X_{111}:** P2q9s_1, **X_{112}:** P2q9s_2, **D_2:** P2q10, **D_3:** P2q11, **X_{121}:** P2q8s_1, **X_{122}:** P2q8s_2, **X_{13}:** P2q12ss, **X_{14}:** P1q9ss; **X_{15}:** P1q12; **X_{16}:** sl (sale size)

Dependent Variable	**Definition**	**Expected sign**
Y = logit ^	Technology-sourcing decision	+:Non-equity

	0= Equity alliance 1= Non-equity alliance	alliance -:Equity alliance
Independent variable	**Definition**	**Expected sign**
X_{111}: P2q9s_1	Perceived level of intellectual property regime (influenced by codifiability and explicitness of the knowledge exchanged)	-
X_{112}: P2q9s_2	Perceived level of intellectual property regime (influenced by the potential partner's free-riding and technology spillover)	-
D_2: P2q10	Perceived scope of the technology development project	-
D_3: P2q11	Perceived scale of the technology development project	-
X_{121}: P2q8s_1	Perceived trust level of the potential partner (in terms of competence aspect)	+
X_{122}: P2q8s_2	Perceived trust level of the potential partner (in terms of goodwill/forbearance aspect)	+
X_{13}: P2q12ss	Perceived level of the technological capability gap with the potential partner	±*

*: Two expected signs due to conflicting predictions

In addition, the following three control variables will be included in the model.

Independent variable	**Definition**	**Expected sign**
X_{14}: P1q9ss	Perceived level of the government support for technological cooperation	?
X_{15}: P1q12	Perceived level of the financial costs of the development	?
X_{16}: Sl	Sale size	?

We tested the significance of the theoretical model by examining whether the addition of independent variables significantly improved the ability to explain the choice between equity alliance and non-equity alliance. The result of the regression analysis is summarised in the table below.

(Table 41) The result of logistic regression analysis in the 2nd stage

	Dependent variable (Choice for alliance governance structure: +: Non-equity alliance, -: Equity alliance)							
Independ	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8

ent variable								
X_{14}	.313 (0.225)	.305 (0.235)	.286 (0.271)	.538 (0.337)	.364 (0.321)	.339 (0.287)	.540 (0.342)	.603 (0.449)
X_{15}	.247 (0.249)	.125 (0.268)	.415 (0.301)	.442 (0.350)	.206 (0.352)	.310 (0.337)	.334 (0.363)	.331 (0.526)
X_{16}	−.143 (0.185)	−.083 (0.196)	−.445* 90.262)	−.201 (0.251)	−.046 (0.260)	−.334 (0.281)	−.161 (0.268)	−.519 (0.443)
X_{111}		.477** (0.239)				.500* (0.277)	.329 (0.332)	.115 (0.459)
X_{112}		−.283 (0.215)				−.453 (0.287)	−.011 (0.290)	−.214 (0.367)
D_2			−3.452*** (0.959)			−3.634*** (1.025)		−2.992** (1.276)
D_3			.669 (0.799)			.879 (0.851)		.655 (1.189)
X_{121}				2.828*** (0.803)			2.874*** (0.837)	2.235** (1.097)
X_{122}				−1.275* (0.701)			−1.373* (0.717)	−1.633 (1.113)
X_{13}					1.360*** (0.357)			.882 (0.541)
N	63	63	63	63	63	63	63	63
−2log likelihood	81.346	76.396	59.192	51.332	48.363	53.839	50.190	32.521
H&L Chi-square	12.214**	3.484**	14.088**	3.806**	10.385**	10.350**	5.398**	10.390**

*p< 0.1, **p<0.05, ***p<0.001

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	P1Q9SS	.603	.449	1.801	1	.180	1.828
	P1Q12	.331	.526	.396	1	.529	1.393
	SL	−.519	.443	1.371	1	.242	.595
	P2Q9S_1	.115	.459	.063	1	.802	1.122
	P2Q9S_2	−.214	.367	.340	1	.560	.807
	P2Q10	**−2.992**	**1.276**	**5.499**	**1**	**.019**	**19.919**
	P2Q11	.655	1.189	.303	1	.582	1.925
	P2Q8S_1	**2.235**	**1.097**	**4.155**	**1**	**.042**	**9.350**
	P2Q8S_2	−1.633	1.113	2.152	1	.142	.195
	P2Q12SS	.882	.541	2.657	1	.103	2.417
	Constant	−12.943	5.899	4.814	1	.028	.000

a Variable(s) entered on step 1: P1Q9SS, P1Q12, SL, P2Q9S_1, P2Q9S_2, P2Q10, P2Q11, P2Q8S_1, P2Q8S_2, P2Q12SS.

The values under the Model 1 to Model 8 are the coefficients of the logistic regression for the independent variables and controlling variables (parentheses indicate the standard error of each coefficient). These coefficients in the models indicate the change in the logarithmic odds of the dependent variable when there is a change of one unit in the independent variable. A variable's positive beta coefficient indicates that the independent variable increases the odds of outcome (dependent variable), that is, it is inclined to choose non-equity alliance as a structure of the technology alliance. A variable's negative beta coefficient indicates its propensity to equity alliance as a structure of technology alliance. In the lower part of the first column, 'N' is the sample size used for the analysis. '-2 log likelihood' and 'Chi-square' (Hosmer & Lemeshow chi-square)'give statistics and test for the effects of the joint significance of the explanatory variables included in the model. 'P' below the table indicates the probabilities. The chi-square values for all the models in the table are all significant, therefore the results of them can be meaningfully interpreted.

The estimated fit of logistic regression models is displayed in the table below. It shows the correct classification percentage of the logistic regression models from Model 1 to Model 8. The correct classification percentage is the sum of the proportion of 'non-equity alliance' responses that were predicted to be 'non-equity alliance' and the proportion of 'equity alliance' that were predicted to be 'equity alliance'. The correct classification percentage in these models ranges from 60.0 & to 90.5 % while the 'hit rate' of a random proportional chance model is 50 %. These results indicate that all models perform better than a random proportion chance model.

Observed		Predicted			Percentage correct
		Equity alliance	Non-equity alliance	Total	
Model 1	Equity alliance	9	17	26	34.6
	Non-equity alliance	8	29	37	78.4
	Total	17	46	63	**60.3**
Model 2	Equity alliance	12	14	26	46.2
	Non-equity alliance	8	29	37	78.4
	Total	20	43	63	**65.1**
Model 3	Equity alliance	21	5	26	80.8
	Non-equity alliance	8	29	37	78.4
	Total	29	34	63	**79.4**
Model 4	Equity alliance	19	7	26	73.1
	Non-equity alliance	5	32	37	86.5
	Total	24	39	63	**81.0**
Model 5	Equity alliance	19	7	26	73.1
	Non-equity alliance	1	36	37	97.3

	Total	20	43	63	**87.3**
Model 6	Equity alliance	21	5	26	80.8
	Non-equity alliance	5	32	37	86.5
	Total	26	37	63	**84.1**
Model 7	Equity alliance	19	7	26	73.1
	Non-equity alliance	3	34	37	91.9
	Total	22	41	63	**84.1**
Model 8	Equity alliance	21	5	26	80.8
	Non-equity alliance	1	36	37	97.3
	Total	22	41	63	**90.5**

Model 1 in the table 38 is the base model which includes the three control variables. None of the coefficients of the control variables are significant. **Model 2** presents the results from the appropriation regime perceived by the respondents. Two dimensions (X_{111} and X_{112}) of the perceived level of the appropriation regime are identified, the former having positive and the latter having negative coefficients. However, the former is only statistically significant. **Model 3** presents the results with the perceived scope and scale of the technology alliance and the mode of technology alliance. The negative coefficients of D_2 (the perceived scope of technology alliance) support hypothesis H1-13 which is that, ceteris paribus, the broader the perceived scope of cooperative activity, the greater the likelihood that the Korean HTSF will choose an equity alliance for new technology development projects. The prediction of the TC perspective is supported with 99 % confidence. However, the positive coefficient of the perceived scale of technology alliance (D_3) is neither in line with the direction of the theoretical prediction nor statistically significant, failing to support the hypothesis 1-14.

Model 4 represents the results of perceived trust level of the potential partner by the respondents, which consists of two dimensions. The positive coefficient of the first dimension (X_{121}: the perceived trust level with the potential partner in terms of its competence aspect) is consistent with the hypothesis H1-15, supported by SN perspective. Thus, ceteris paribus, the stronger the perceived trust level with the potential partner in terms of its competence aspect, the greater the likelihood that the Korean HTSF will choose non-equity alliance for new technology development projects. This is confirmed with 99 % confidence. The negative coefficient of the second dimension (X_{122}: the perceived trust level with the potential partner in terms of its goodwill/forbearance aspect) is also supported with 90 % confidence. However, this is not consistent with the theoretical prediction; thus, further examination is necessary in the next section. **Model 5** presents the result from the impact of the factor X_{13} (perceived level of technological gap with the potential partner) on the mode of technology alliance. The positive coefficient of the X_{13} supports the hypothesis H1-16 which is that, ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the Korean HTSFs will choose an non-equity alliance for new technology development projects. The prediction of RB and SN perspectives is supported, rejecting that of MP perspective with 99 % confidence.

Model 6 represents the combined effects of the two independent factors: perceived level of the appropriation regime and the perceived scope and scale of the project in association with controlling variables. **Model 7** represents the combined effect of two independent variables: the perceived level of the appropriation regime and the perceived trust level with the potential partners. Lastly, **Model 8** presents the combined effects of all independent and control variables on the dependent variable. The impacts are similar to what we have learned from the previous model found from the backward elimination method. Although the beta coefficient values are slightly changed, predicted direction remains the same. For instance, the impact of the D_2 and X_{121} are significant with 95 % of significance. But, the impact of X_{13} becomes much diminished in the final model. The results of model 1 to 8 provide strong evidence for two hypotheses (H1-13 and H1-15).

The following is the summary result of the hypotheses based on the combined effect of all independent variables. Tick (√) indicates identified impacts from the model testing in accordance with the predicted direction of the hypotheses. However, tick (√) with parenthesis is only significant statistically with 90-95 % confidence.

(Table 42) Summary of the hypothesis test

	Hypotheses	**Result of the theoretical prediction**

H1-12	**(Perceived level of appropriation regime)** Ceteris paribus, the weaker the intellectual property regime (appropriation regime), the greater the likelihood that the Korean high-tech small firms will choose equity alliance	TC, RD	
H1-13	**(Perceived scope of technology development project)** Ceteris paribus, the broader the perceived level of scope of cooperative activity (not only including R&D activities but also manufacturing, marketing and/or supply activities as well), the greater the likelihood that the Korean high-tech small firm will choose an equity alliance for new technology development project	TC, RB	√ (signif-icant)
H1-14	**(Perceived scale of technology development project)** Ceteris paribus, the broader the perceived level of the scale of cooperative activity (not only limited one technology but also covering range of products/technologies), the greater the likelihood that the Korean high-tech small firms will choose an equity alliance for new technology development project	TC, RB	√
H1-15	**(Perceived trust level with the potential partners)** Ceteris paribus, the stronger the perceived level of trust with the potential partner, the greater the likelihood that the Korean high-tech small firms will choose non-equity alliance for new technology development project	SN	√ (signif-icant)
H1-16	**(Perceived level of the technological capability gap with the potential partner)** Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the Korean high-tech small firms will choose an non-equity alliance for new technology development project.	RB, SN	√
	Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the Korean high-tech small firms will choose an equity alliance for new technology development project.	MP	

(TC: transaction cost perspective; RB: resource based perspective; RD: resource dependence perspective; MP: market power perspective; IST: institutional perspective)

Discussion

This study proves that deciding appropriate structure of technology alliance is contingent on several factors, playing as an ex-ante mechanism for structuring technology alliance. The majority of the identified factors have an impact in hypnotised direction that this study suggested and some are proved to be statistically significant. Interpretation of the estimated impact of the explanatory factors is made next based on complete logistic regression model (Model 8) in the table 40.

Hypothesis 1-12 proposed that, ceteris paribus, the weaker the intellectual property regime (appropriation regime), the greater the likelihood that the Korean HTSF will choose equity alliance. This hypothesis was based on the assumption that the key issue for pro-alliance respondents should be whether they will be able to seize an appropriate return from the cooperation. Numerous studies warn that the firm should not take too little on this issue especially when the appropriation regime is suffering from knowledge leakage or diffusion to the partner, ineffective patent-protection law and tacitness of exchanged expertises (Gulati & Singh 1998; Teece 1986). In response, they recommend that strong equity ownership and hierarchy control is the remedy for curing such problems under a weak appropriation regime. This argument was tested in two dimensions, but none was statistically significant in this research.

The failure to support the above argument can be explained, based on the descriptive data collected. According to the descriptive analysis on page 287, we find that the respondents do not particularly perceive that the appropriation environment surrounding their incumbent cooperative technological projects is characterised by difficulties in fairly seizing the return from the cooperation project. Based on this result, two scenarios can be suggested. First, it appears that the responding firms are likely to be recipients of technological expertise from the partners, thus, their concerns for knowledge-spillover and diffusion to partners may not be a serious issue in governance decision of technology alliance.

Second, attributes of public property of technology, network externality and "free-riding" have long been the cause of discouraging the innovative activities of Korean HTSFs (Lee 2000). When this phenomenon becomes prevalent, the firms tend to avoid innovative attempts for the competitive projects because exclusive rights and incentive from such efforts will yield little profit; their pioneering achievements will be outweighed by the costs arising from unintended leakage and poor legislative protection of the knowledge property by which followers will become the key beneficiary (Lee 2000). This inevitably declines the overall intellectual and technical standard of the technology projects that the Korean HTSFs are undertaking. Therefore, it is suspected that the respondents' lower concern on the appropriation issue from their technological cooperation may reflect that their technology projects tend to be less competitive based on the lower technological standard. In this case, a fair seizure of the return from cooperation would be less problematic because the risk of unintended knowledge transfer will be less due to the less complicated boundary of the project and governance provision may be able to cover a wider fraction of the skills that could potentially flow from one to another. With this in mind, cooperation in the form of equity ownership to prevent appropriation hazard may be of no use.

Regarding hypothesis 1-13, we found that the respondents tend to choose non-equity alliance when the scope of alliance covers R&D activity only, rather than marketing, manufacturing and supply activity. This strongly supports the prediction of the TC perspective, implying that the respondents select alliance governance mode based on difficulty level in specifying contract to prevent shirking, cheating and misappropriation of the intellectual property in their technology alliance. These difficulties are the source of high transaction costs and these can be reduced with a hierarchy-like governance mode such as equity joint venture. Indeed, specifying a contract would be convenient as the cooperative activity contained in the contract is rather focused and narrow, non-equity alliance is a sufficient mode to proceed with the cooperative project. Regarding hypothesis 1-14, the insignificant impact of the complexity of the technology alliance in terms of the number of technology/products involved may be invalid in this study because only sixteen respondents are undertaking cooperative projects covering more than two technologies simultaneously; to verify the impact of perceived scale of the technology alliance, more extensive data might be necessary.

Hypothesis 1-15 proposed that, ceteris paribus, the stronger the perceived trust level with the potential partner, the greater the likelihood that the Korean HTSF will choose non-equity alliance as a mode for technology alliance. Two dimensions were tested and the Model 8 proved that perceived trust level, in terms of the partner's devotion and faithfulness to the cooperative projects, has a significant impact with 95 % confidence. The SN perspective is supported. Cooperation is realisable only when there exists mutual trust and commitment between engaged parties, otherwise, there is no point in cooperating. However, the descriptive statistics (see, pp. 293) shows that the respondents are not necessarily confident about their potential partner's goodwill and faithfulness. It appears that this response is not so much because many respondents discredit the potential partners, as because they are unaccustomed to them or have no knowledge of them, reducing overall perceived trust level (see pp. 281). This may be the typical problem of nascent small firms in their governance decision of cooperation. Therefore, the respondents' credit for the potential partners in terms of trustworthiness, either gathered from the respondents' incumbent social network or tips from the third parties, may affect the respondents' final governance decision for technological cooperation.

The result of the analysis demonstrates two noteworthy implications. First, the decision-maker of a firm must be able to assess the trustworthness of the potential alliance partner in order to structure the appropriate alliance goernance mode. However, assessing the trustworthiness may not be simplistic as it is closely linked to fundamental social, psychological norms and customs. The analysis reveals that the respondents value the partners' devotion and faithfulness to the cooperative commitment as the essential component of the trust, which is reflected in their alliance governance decision, weighing more on psychological components than economic component. This opens further investigation opportunity into how the information of those psychological aspects of trust emerge and develop over time among and between unacquainted and previously non-related firms, small and nascent venture firms in particular.

Second, having trusted in the partner's faithfulness, it is found that the respondents choose not to rely upon detailed contracts based on equity ownership. Literature suggests that, within the context of complex technological cooperation projects, it is necessary to have a detailed and formal equity-based contract; doing so reduce the transaction costs, make partner behaviour more predictable, expectable and committed (see Chapter 4, pp.101). Where there is trust, it counteracts fear of unpredictable partner's behaviour and is likely to limit the transaction costs associated with exchange (Gulati 1995). As far as Korean HTSFs are concerned, a detailed negotiation contract based on equity ownership and control may not be necessary as it obstruct the generation of good exchange environment. Indeed, trust is used as some degree of substitute for control mechanism, which can be seen in equity-based formal inter-firm relationships. With a trustworthy partner, drafting a detailed contract would be costly and time consuming; instead, non-equity alliance with the lowest level of safeguard would be sufficient.

Lastly, regarding hypothesis 1-16, the Model 8 of the analysis demonstrates a positive coefficient consistent with what the RB and SN perspectives predicted; ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the Korean HTSF will choose a non-equity alliance as a mode for technology alliance. The predicted direction suggested by MP perspective is not relevant in this study. However, unlike in multivariate analysis seen in pp.301, the coefficient is significant slightly less than 90 % confidence in this holistic analysis (sig=0.104); small sample size may affect the result. This study, however, tries to view this as significant factor for the benefit of the future research.

A few reasons can be explained by the result. First, given the condition that the cooperative project is not always 100 % guaranteed for its commercial and technological success, a larger technological capability gap between the partners (either by the respondents' superiority or inferiority) will lower the complementarity of the capability, hindering enjoyment of the expected synergy from the cooperation. Thus, premature decision for equity ownership through joint venture may increase the opportunity costs of commitment by the same amount as the partner's equity, and cause to internalization of the risk associated project. This will be critical to small-sized respondents. Therefore, instead of jumping to the large stake of equity ownership when the respondents perceive a greater technological capability gap with the partners, they can increase its equity level of ownership gradually depending on the process and achievement of the project. This is a much safer way of committing to a cooperative project. Second, technologically superior firms already possess advantageous bargaining power over less capable firms, without relying on voting rights of the board, thus forming equity-alliance with them is less useful.

Organisational fit, the similarity in technological capability in particular, determines the extent to which partnering firms cooperate well and realize anticipated synergy critical to the alliance's success. The role of organizational fit is more eminent in equity-based alliance such as joint venture because it requires a very close interaction, heavy reliance, and virtually mutual contribution between engaged partners. Joint venture can be successful only when both partners fit well so that they readily identify and facilitate tacit and articulated knowledge, effectively capture potential learning embedded in the alliance relationship and enhance the appropriability of knowledge. In this sense, the ultimate condition for equity alliance and joint venture to be formed is to have a common frame of reference and capability between partners, otherwise, the chance of successful equity alliance is very low. When the partners have dissimilar technological capability, the formation of a joint venture is not an appropriate choice. It appears that the respondents readily accept this logic and would be likely to choose non-equity alliance under technologically-dissimilar conditions with potential partners.

Chapter 10: Conclusion

Recent studies have reinforced the strategic importance of new technology development and innovation in order for firms to survive competition and remain viable in the market. Given these circumstances, the firm's choice of technology development method has emerged, as perhaps the most crucial decision confronting top-level decision-makers. Many scholars have increasingly recommended a technology cooperation approach to the new technology development, emphasizing various benefits of alliances and describing it as if it could dramatically transform small firms, enable them to be more competitive and increase the likelihood of innovation projects' success. Nevertheless, empirical research has displayed disappointing results of cooperation without convincingly identifying the source of such disappointment.

The purpose of this study was to investigate why not all Korean high-tech small firms (HTSFs) in the telecommunications industry are pursuing technology alliance as a technology-sourcing method for technology development projects if technology alliance is beneficial. This study reviewed various theoretical perspectives in an attempt to answer this question by investigating the requirements and best conditions for forming technology alliance, but no common ground was reached. Indeed, whether or not to choose technology alliance for new technology projects would be one of the key issues for decision-makers as technology alliance could not only enhance the competitiveness of the firm but also undermine it.

Against the background of this issue and enthusiastic claims for collaborative strategies for new technology projects, this study tries to contribute to the decision-making process by identifying key determinants in deciding the appropriate mode of new technology development projects. For doing this, this study, unlike others using small samples in favour of prominent cases in developed countries, has relied on extensive field research and data analysis gathered from representative samples of technology innovation projects undertaken by Korean HTSFs. In this respect, this study is a pioneering attempt to hypothesize about technology alliance activities of Korean HTSFs, testing representative examples from one industry sector across an entire nation and shedding light on the role of some key determinants that influence their technology-sourcing decisions.

The following two key research questions were suggested:

(1) *Under what conditions, do HTSFs choose external sourcing modes (i.e., technology alliance) or internal sourcing (i.e., in-house development) for new technology development?*

(2) *If they choose an external sourcing, why do they choose different external sourcing methods for new technology development?*

A two-stage contingency model was designed to answer the two research questions, identifying internal and external contextual characteristics and dimensions relevant to the technology-sourcing decision. Various determinants were identified from strategic management literature but the directions of the hypothesized impacts differ widely depending on which theoretical perspective is adopted.

Eleven hypotheses in stage one and five hypotheses in stage two were generated to verify their presumed effects, as well as examining the explanatory power of various theoretical perspectives. 258 responding firms from a 1,160 population were used in testing a total of sixteen hypotheses based on logistic regression analysis. Five determinants in the first decision-making stage and two determinants in the second stage are found to be statistically significant. Using a two-stage contingency framework provided good discrimination in separating firms that engaged in technology development projects from those who proceeded through technology collaboration. Based on the findings from the analysis explained in the Chapter 8 and 9, we can draw the following implications.

10.1 Practical and methodological implication

Only one in four (25 %) of Korean HTSFs (63 firms among a total of 258 respondents) were actually engaged in a technology alliance for new technology development projects. Lack of secondary data makes it impossible to determine whether such a rate is typical in the global perspective, as far as HTSFs are concerned. However, this rate is much smaller than generally expected. On the other hand, it is found that, in general, the respondents were almost five times more likely to form informal rather than formal cooperation; this is because the former is driven more by accidental (unplanned) opportunities than by precise intentions and organisational strategies. However, there is less empirical evidence to explain to what extent such informal interaction is as contributable as a formal technology-sourcing decision in undertaking technological innovation activities, although it is conventional to claim that innovation ideas often stem from a fresh blending of ideas, knowledge and experience in informal interaction. This finding remains an area for further research inquiry.

What distinguishes firms choosing in-house development from those choosing technology alliance for new technology projects? This was the key research question. According to the findings of this research, the decision-makers' perception of their firms' internal, external and project factors provides the decisive influence. Therefore, recommending a technology alliance for technological innovation project may be invalid without addressing and considering these five perceptions. As to the firm's internal factors, we found that:

- the respondents were more likely to choose in-house development as the proportion of R&D workers among total employees was larger

On the contrary,

- the respondents were more likely to choose technology alliance when they perceived that they were more entrepreneur-oriented

As to the project factors, we found that;

- the respondents were more likely to choose technology alliance when the perceived level of redeployability of the invested assets was higher

- the respondents were more likely to choose technology alliance when the perceived level of the technology uncertainty of the project was higher

As to the environmental factors, we found that;

- the respondents were more likely to choose technology alliance when the perceived level of the legitimacy for the alliance was actually higher

Based on the collected data, these five significant factors and their effects can be expressed in the following equation model;

$$\mathbf{Logit^{\wedge} = 6.391 + 2.430X_2 - 0.431X_4 - 0.332X_{53} - 0.415X_7 - 0.424X_{10}}$$

where

X_2: Proportion of R&D workers

X_4: Perceived level of strategic orientation of the entrepreneur

X_{53}: Perceived level of the redeployability of the invested assets

X_7: Perceived level of technology uncertainty

X_{10}: Perceived level of the legitimacy of the alliance

Using this model, we can estimate how variation of these factors would influence the probability of choosing in-house development (mode=1) over technology alliance[18] and choosing equity alliance and non-equity alliance.

[18] To do this, we simply plug in relevant information (that is, value of the X_i, to the equation model, then we can obtain the logit-value. Then we can transform the logit-value (logged-odds value) back into the probability of an occurrence of in-house development by using probability model P_i (mode=1) = $1/(1 + e_{-y})$ in which y is logit value.

What distinguishes alliance-choosing firms between equity alliance and non-equity alliance? This was the second research question. This study proposed that the contract hazards influence their choice of technology alliance mode. This study proposed that the perceived level of the contract hazards can be measured by the decision-makers' perception of the appropriation regime of new technology, the scope and scale of the technology project, the trust level with the potential partner and the technological capability gap with the potential partner. This research found that;

● the respondents were more likely to choose equity alliance when the perceived scope of the cooperative activity is broader

(Alternatively, they were more likely to choose non-equity alliance when the perceived scope of the cooperative activity is narrower)

● the respondents were more likely to choose non-equity alliance when the perceived trust level with the potential partner's competence is stronger.

(Alternatively, they were more likely to choose equity alliance when the perceived trust level with the potential partner's competence is weaker)

In addition, this research suggests further investigation on whether the firms are more likely to choose non-equity alliance when they perceive a greater technological gap with the potential partner, as the effect of this factor is marginally not supported at α =0.1 level (p(0.103)). Based on this results, we can formulate the following equation.

$$\mathbf{Logit\hat{} = -3.806 - 2.586\, D_2 \quad + 2.022\, X_{121}}$$

where

D_2: Perceived scope of the technology development project

$X121$: Perceived trust level of the partner's competence

The result of the calculations of the above two models can be referred to A appendix 3-4.

The findings in this study have important methodological implications to the HTSFs in newly-industrialised nations. First, there has been the gap between the alliance proponents and the real decision-makers about the utility of inter-firm collaboration as a competitive technology-sourcing strategy. Due to lack of empirical studies on HITSFs, it was difficult to compare its usefulness to that of other technology-sourcing strategies. This study is the first attempt to evaluate the HTSF's practical use of technology as a competitive technology-sourcing strategy in Korea. To achieve this, this study has used careful population selection strategy based on stratified random sampling and questionnaire surveys via graphically designed on-line distribution to improve the validity and reliability of the data, in association with the leading Korean Market research firm. This approach was far more effective than that of existing studies (i.e., Kim and Lee 2003), in terms of time-spent in data collection and additional feedback without missing information, so that the replication of the methodological procedure in this study can be applied to other settings in the newly industrialised nations.

This study also has several managerial implications. First, the respondents are more likely to develop their knowledge internally as they have more development experience and stronger capabilities. The managerial implication tells us that firms have to evaluate their own experience and capabilities when they are considering technology-sourcing decision. When the respondents recognize that certain technological knowledge is needed, they will be more confident in developing the knowledge internally, based on their previous experience and their own sufficient capabilities. As firms develop the knowledge that match their own experience and capabilities, and they are familiar with the new technology project in relation to their existing knowledge, it will be appropriate for them to acquire it internally.

On the other hand, organizational climate factors have significant effects on the choice of technology-sourcing method. These findings show that firms are more likely to choose the external technology-sourcing method in the entrepreneurial organizational climate, characterised by a higher level of innovation, risk-taking and pro-activeness. On the other hand, in-house technology sourcing is favoured as firms do not have such an organizational climate. We found that a clear, positive and aggressive intention of the entrepreneurial decision-makers can enable a consensus to be reached among various management and employees, and foster their commitment to knowledge creation. Entrepreneurial decision-makers can motivate the individuals within and outside the firms to introduce new ideas for new knowledge creation and they can cope with many contingencies in knowledge creation. Accordingly, entrepreneurial firms would be more comfortable in developing the knowledge creation externally.

Second, regarding the environmental factor, the respondents are more likely to choose in-house development in the less munificent and dynamic environment. On the contrary, outside knowledge sourcing through technology alliance is favoured in the more munificent and dynamic environment. The managerial implication of this result is that because technological knowledge has become an essential strategic resource for firms to enhance their competitive advantages, firms need to learn in different environmental conditions, and so they need to select different knowledge-sourcing methods in response to external pressure and change. The empirical evidence reveals that in order to reduce development risks and create more strategic flexibility, firms would be more willing to mimic other leading firms' technology alliance strategy than to develop internally, in order to reduce new technology development risks and create more strategic flexibility. Third, for the technology project factor, the results of the logistic regression analysis show support for the direct effect of technology-sourcing method. These findings indicate that firms are more likely to choose the external technology sourcing method as the target knowledge is more specific to the respondents. From the perspective of core competence, firm-specific knowledge is unique to the firm and can be a source of competitive advantage. Therefore, the respondents try to create this type of knowledge externally even though the creation process involves high failure risks and development costs. On the other hand, for acquiring general knowledge not critical to the firm's core competence, the respondents perceive that it will be appropriate to acquire this type of knowledge from internal sources such as their own R&D department. The managerial implication is that firms tend to choose internal development method for unimportant knowledge while they choose external method for strategically important knowledge.

Combining all the factors together, the general managerial implication to the responding firms is that, only when all the perceived levels of the strategic orientation of the entrepreneur, the re-deployability of the invested assets, technology uncertainty, and the legitimacy of the alliance are relatively high, and the perceived level of the technological capability is relatively small, all the firms more likely to choose technology alliance (please see the appendix 3-4 for this issue). In reality, however, such cases would hardly ever appear. Thus, it is clear why the number of responding firms choosing technology alliance is much small than those choosing in-house development.

Firms choosing technology alliance are likely to consider contract hazards in order to decide the relevant structure of the alliance. Various factors may influence the structuring alliance, however, this study found that trust level and the scope of the potential technology project are the key elements in determination of structuring alliance, prevailing over all other factors. However, we can say that they are more likely to choose non-equity alliance when the perceived trust level with the partner increases, regardless of the perceived scope of the cooperative activity being narrow or broad. Therefore, this study obviates that selecting the trustworthy partner is the utmost priority in structuring alliance.

Finally, in a time of increasing uncertainty, the approach to technology-sourcing decision is particularly important to the success of the company. In making decisions, managers should not be totally influenced by their past decision-making patterns, alliance proponents or practices of other players in the industry. Instead, they have to determine what the best conditions for each decision-making will be, and where they fit best. Unfortunately, there are many contingencies that the inexperienced HTSFs may face in their technology sourcing-decisions, which mire their decision-making process, and no academic research has suggested a proper guideline. This study provides a good guideline for future decision-makers of HTSFs regarding which contingencies are particularly important to consider among others, so that they will be able to choose to "ally" or "avoid ally" in strategically important areas with minimal risks of failure.

10.2 Theoretical implication and contribution

Despite the fact that business researchers have increasingly paid attention to the technology alliance behaviour of emerging high-tech firms, lack of empirical evidence leaves us with far from consistent theoretical perspective on the phenomenon. Even today, any attempts to answer the similar question held in this study finds little data that is theoretically substantiated as well as empirically defended. This study envisaged that a more outright and differentiated theory could be developed only through synthesis of various theoretical perspectives and precise empirical investigation. Having said that, this research found that some theoretical perspectives and methods should be re-illuminated in the alliance studies.

First, a multi-facet approach that synthesizes a significant stream of theories is very important for research in the field of inter-firm relationships, instead of studies focusing on a few and debating which theories are superior to the other (i.e., Gulati 1998, Pisano 1990). Unlike these studies, this study is built on a much more rigorous, multi-faced theoretical approach compared to other studies.

Of course, some studies (see, Vornotas & Safioleas 1997; Auster 1994; Varadarajan & Cunningham 1995; Vyas, et al. 1995; Gray & Wood 1991) have stressed the importance of the integrative approach in alliance studies, but they fail to provide empirical results from this approach, lacking validity and reliability of their arguments. This study substantiated their incomplete efforts by showing the integrative approach allows much more rigorous explanation of alliance formation. They also stressed the internal and external environments playing an important role in the assessment of the alliance formation without stating the underlying factors of each environment. Various observable factors identified in this study provide a valuable basis for their studies. However, the identified factors (technological capability, strategic orientation of the entrepreneur, technology uncertainty and legitimacy of the alliance, in particular) are situation-specific; they could vary in importance from one circumstance to another when testing for individual effects. Therefore, using the same factors suggested in this study, other researchers can replicate their estimation for different situations relevant to their study setting.

Based on the multi-facet theoretical rationale, this study found that economic-based and strategic-based perspectives focus on, respectively, economic efficiency and sustainable competitive advantage; and sociological and institutional approaches focus on network position of the focal players and embedded inter-firm relations, as influential to the technology-sourcing decision. An effort has been made to identify what these perspectives have in common and how they oppose each other; by doing so, an integrative framework has been built. As we have seen, these research findings witness that TC (transaction costs), RB (resource-based), MP (market power) and INST (institutional) perspectives are all critical in explaining technology-sourcing decision of HTSFs.

Second, this study revealed that the unique feature of Korean HTSFs is that they are rather influenced in their isomorphic pressure by the powerful non-peer group outsiders, competitors or client firms, when they face the complex nature of risk and opportunity appraisal. Various authors (i.e., Rumelt, Schendel & Teece 1994; Oliver 1990; DiMaggio & Powell 1983) have mentioned that 'mimetic isomorphism', the process of organizations imitating others that are perceived to be legitimate and successful, should be considered as the key determinant in understanding alliance phenomenon. As they lack empirical support in to what extent the 'mimetic isomorphism' is portrayed during the strategic decision-making process in the various industrial settings, this study substantiated their studies within the context of small firms. This study firstly found that 'mimetic isomorphism is applied to the strategic alliance phenomenon within the context of HTSFs. This study argues a feature of Korean high-tech industry is that, to some extent, strategic decision-making (in this case, technology sourcing decsion) is more closely associated with approval and disapproval of significant others (in this case, successful few or dominant opinion of society), causing imitative behaviour of followers (in this case, small Korean HTSFs). In order for this finding to be firmly established as a key determinant of alliance formation and to explain why conformity with a salient other's alliance strategy is perceived to be so important, further empirical test using HTSFs in other nations with various sociological and psychological contexts is essential.

Third, the transaction cost (TC) perspective and resource based (RB) perspective have been the most popular, but contrasted sharply, in explaining alliance formation. However, it appears that the present stream of academic research commonly consents on the diminishing explanatory power of transaction costs (TC) perspective in alliance studies. For instance, Gulati (1998, 1995) and Madhok (1996, 1995) support that the boundary decision of a firm is becoming more influenced by the firm's perception of the enhancement of the competitive advantage and accessibility of the valuable resource rather than their assumption of reducing opportunism and transaction costs. In line with them, Yasuda (2005), Das and Teng (2000) and Tsang (1998) compared the TC and RB perspectives to identify the rationale for alliance formation and the selection of the governance structure of strategic alliance, and they found that the resource-based perspective prevails over the transaction costs perspective in their studies' settings.

However, this study starkly contrasts to their studies; the TC perspective is still the dominant logic to the technology-sourcing decisions of Korean HTSFs. Several implications can be drawn from this finding. In an interview, the director at Strategic Planning Group in Turbotek, one of the responding firms with around 120 employees, pointed out the key issue that contradicts to the RB perspective's strategic recommendation. He said that;

> "From the small firm's point of view, I believe that economizing is still key consideration area in strategic decision-making. Of course, many contemporary strategy professionals stress the importance of competitive advantage based on long-lasting, unique and non-imitable resources. It is correct for them to recommend small firms like us to actively engage in strategic alliance that helps us to possess such resources that we may not capable of doing alone. However, its sounds for us like small firms are unrealistic and remote. We have to check the status of profit earned every quarter of the year. The technology that we are trying to develop through a project should be profitable and commercially viable within one or two quarters after it is on the market, otherwise, it is of no use. We know that developing such resources requires time, high costs, risks, patience and collaboration with competitive firms. If we are extremely ambitious to be the up front leader in the global market, based on unique and non-imitable resources like Intel has, certainly strategic alliance should be at the centre of our various strategic options. However, we do not go that far; probably other firms of similar status are in a similar opinion. Unless we are extremely ambitious followers of the RB theorists, strategic alliance is still too costly an option. The

prescription of the RB perspective is too idealistic because it tells us how to survive in the long term but does not tell us how to survive in the short-term."

Based on the brief comment from the interviewer above, it appears that the RB perspective does not reflect the immediate strategic concern of a small firm: how to develop new technology at lower costs. In this respect, strategic alliance is an expensive strategic option, instead of cheaper one. As the theory mostly focuses on the large global firms who can spare economies of scale and scope, it is necessary for the theory to concern how small firms would be able to build core competence and valuable resources based on economic efficiency and survive alone at the initial stage.

Having stressed the explanatory power of TC perspective, the result of this study is in line with those of Chen & Chen (2002) who have been studying technology-sourcing decision of HTSFs in Taiwan. We found that both Taiwanese and Korean high-tech firms consider that asset-specificity and behavioural uncertainty prompt firms to choose more hierarchical control in technology-sourcing decision, supporting that the logic of TC perspective prediction is relevant and generalisable to the case of high-tech firms in newly industrialized firms such as those in Taiwan and Korea. However, this study went further than the study of Chen & Chen (2002) by explaining how HTSFs would be able to reach technology cooperation before choosing its specific structure.

10.3 Limitation and direction for future study

Like all other studies, this research also has some limitations that must be taken into account when assessing its contribution. Firstly, this study may have some limitations in generalizing the research findings. As we have seen, a single high-tech industry sector in one nation is investigated in order to establish a tightly regulated environment for the research. Given this limited focus, our findings may be confined to this specific group of firms in a specific industry, and may not be applicable to other types of industries. On the other hand, this study used the one-shot and cross-sectional data: the technology-sourcing decision in the most recent period of time. However, it is possible that the decision-makers may shift their technology-sourcing pattern into a new direction as the market conditions and regulations change. For further rigorous research design, investigating decision-making at various time-periods is necessary.

Secondly, this study can be thought of only as exploratory research with convenient sampling. -Although the response rate is around 25 % (an average response rate for small firm study in general) and results are significant, a larger response might affect the research finding. At the same time, this study relies on single informants and there is the possibility of respondents' self-report bias or recall-bias in the collected data. For instance, they may not accurately perceive the strategies of the organisation or they may or may not have coincided with what they actually favoured; government regulation, contractual obligation or other issues may force them to alter their preferred choice. Because this study has only focused on quantitative and normative approaches, further comprehensive qualitative assessment is required to understand such issues. In addition, the framework in this study does not provide a guideline for distinguishing successful choice from failure. Therefore, we should be cautious in recommending the research finding to prospective entrepreneurs; they must look at the list of variables in the models and assess their strength subjectively.

Thirdly, this study concentrated on the decision as to whether to cooperate or not, observed at particular points-in-time; however, it omits factors relating to how inter-organisational relationships developed overtime and how this influences the choice of the technology alliance structure. In this respect, it would be interesting to extend the current study to the dyadic level and investigate whether an embedded information relationship between firms could be a significant moderator of a firm's technology-sourcing decision. Treating alliance as a uni-dimensional phenomenon and dichotomy of decision-making (in-house development vs. technology alliance, and equity alliance vs. non-equity alliance) may also bring out simplification and shortcomings, as it does not consider the wide array of cooperative arrangement. Unfortunately, the limitation of the data set, time-span and budget prevents this research from making further refinement.

Fourthly, it is found that there are inconsistencies between the prediction of the literature and this study; only 7 of the total of 16 factors identified as influential factors were significant in this study. Although it is typical in many statistical researches, some variables are somewhat moderately correlated with each other, having Pearson correlation around 0.4 and some measurements have moderate reliability with less than 0.7 Cronback's alpha value. In this case, there is a possibility that some variables are biased toward insignificant. Therefore, richer conceptualisation, further improvement of the proxy measurement and duplicating of the research findings to various contexts are needed to provide validity and reliability.

Lastly, but most importantly, this study may take less into account the importance of cluster issue in alliance formation which has received a growing attention over recent years. Cluster means a remarkable collective activism in which significant resources have been mobilized to create an infrastructure of supporting services ranging from training and educational programs to international marketing and information-providing agencies. Throughout this research, the author has found that globalisation and internationalisation reinforce, rather than dilute, local specialisation for high-tech small firms; increasing numbers of Korean high-tech small firms tend to local specialization as a means of maintaining their market positions to weather global competition. As a result, a lot of Silicon Valley-like towns in Korea have been rapidly formed and organised in the middle- and Northern part of the Korean Peninsula (TangJung, DaeJun and PaJu, to name the notable ones). Although the respondents in this study are not located in these geographically clustered areas, many high-tech small firms are clustering throughout various communications methods which geographical location is becoming less important. Does being in a cluster through the internet-related communication devices influence the potential possibility of alliance formation?

This study assumes that the characteristics of the cluster may influence the firms to choose technology-sourcing decision. Being in a cluster based on various communications and internet-related communities, with or without geographical proximity means better access to information, knowledge, skills and experience and, at the same time, improved linkage and various cooperation between clusters and local members. Technological alliance is more likely to form when the ties in the clusters are strong and passive because it is effective at transmitting information between participating firms. The clustering of Korea HTSFs is a relatively recent phenomenon; they are formed by the government-led project for the information society in the late 90s or early this decade as an benchmark of Silicon Valley, so the members' ties in the clusters tend to be weak as yet, except for a few distinguished ones.

Bonding strong ties is a significant requirement not only for successful alliance but also for innovation. Weak ties may be effective in exchanging with other firms with different ways of viewing the phenomenon, thus, important for the introduction of new perspectives and ideas. However, weak ties do not provide sufficient conditions to form alliances because high-tech small firms are not likely to form alliance to simply exchange ways of working and new ideas, given the gravity of the new technology development project. In this case, the respondents do better to evolve the bond progressively, based on long-term personal association from which trust and reciprocal relations emerge. Only then, may formal technological collaboration finally occur.

In this respect, the atmosphere of several industrial clusters in Korea has not matured enough for various small firms to abstain from local competition and actively engage in technological cooperation for mutual gains. Having said that, it appears that the priority in understanding the alliance formation is to analyse the underlying attributes of the industrial cluster or web-based communities in which concerned firms are embedded. This includes how the cluster has emerged and evolved, what the inherited local resource and formal and informal institutions are, what the status of the firms in the cluster is, what is the proximity level of the members, whether the clusters have the capacity to respond to opportunity and crisis and whether the cluster simply replaces the role of strategic alliance so that firms in it do not need to rely on the formal inter-firm relationship. Indeed, while clusters may be localized entities such as regions, they may constitute elongated bonds and ties from which forming strategic alliance can only be understood.

Despite some limitations, this study provides several avenues for further research. Firstly, some significant factors provide a preliminary basis attracting further investigation. For example, further elaborating the sub-dimensions of the perceived entrepreneurial strategic orientation is highly needed, as it is found to be a significant factor in this study. This study aggregated various sub-dimensions of the entrepreneurial strategic orientation into a single one. This may ignore the contribution of the individual sub-dimensions to the technology-sourcing decision and cause inadequate controlling for the type I error. It is the purpose of future research to compare the link between different constructs of sub-dimensions and assess their interactions. On the other hand, the impact of the perceived pressure of the social legitimacy for the alliance on the technology-sourcing decision also demands further inquiry. To investigate this in more detail, examining cross-cultural and psychological aspects instead of economic propositions, is worth studying.

Secondly, despite some confirmed causal relationship between explanatory and outcome factors, interactive impacts between explanatory variables are not examined. This study believes that perceived market growth rate and perceived trust levels with the potential partner may influence decision-making in each stage as intervening variables, as they are found to be so in some other studies (i.e., Pak, et al 2002). In addition, significant causal relationship can be reassured and recommended to the potential entrepreneurs if we were to identify the impact of particular decision-making to the outcome performance, whether any particular choice results in a successful technology project or not.

In conclusion, although there are some limitations and further study remaining to be done, this study has provided a systematic test of the conditions for structuring technology projects of HTSFs and normative industry experience from it. This study is fruitful since the target was entrepreneurs in newly-industrialised nations who received relatively little academic attention as to their strategic behaviour. The conceptual framework proposed is found to be of value in explaining mode of innovation development, helping the firms in the decision process regarding whether to form alliances or to engage in internal technology development. Therefore, the research findings could offer guidance on the management-decision process based on the identified variables, and is worth examining in other newly-industrialised nations.

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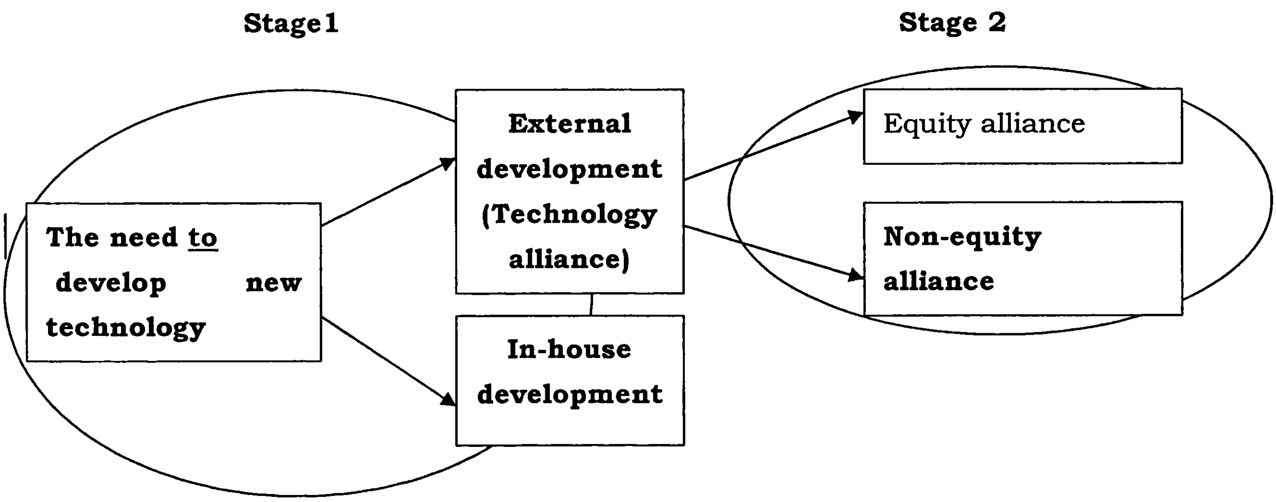
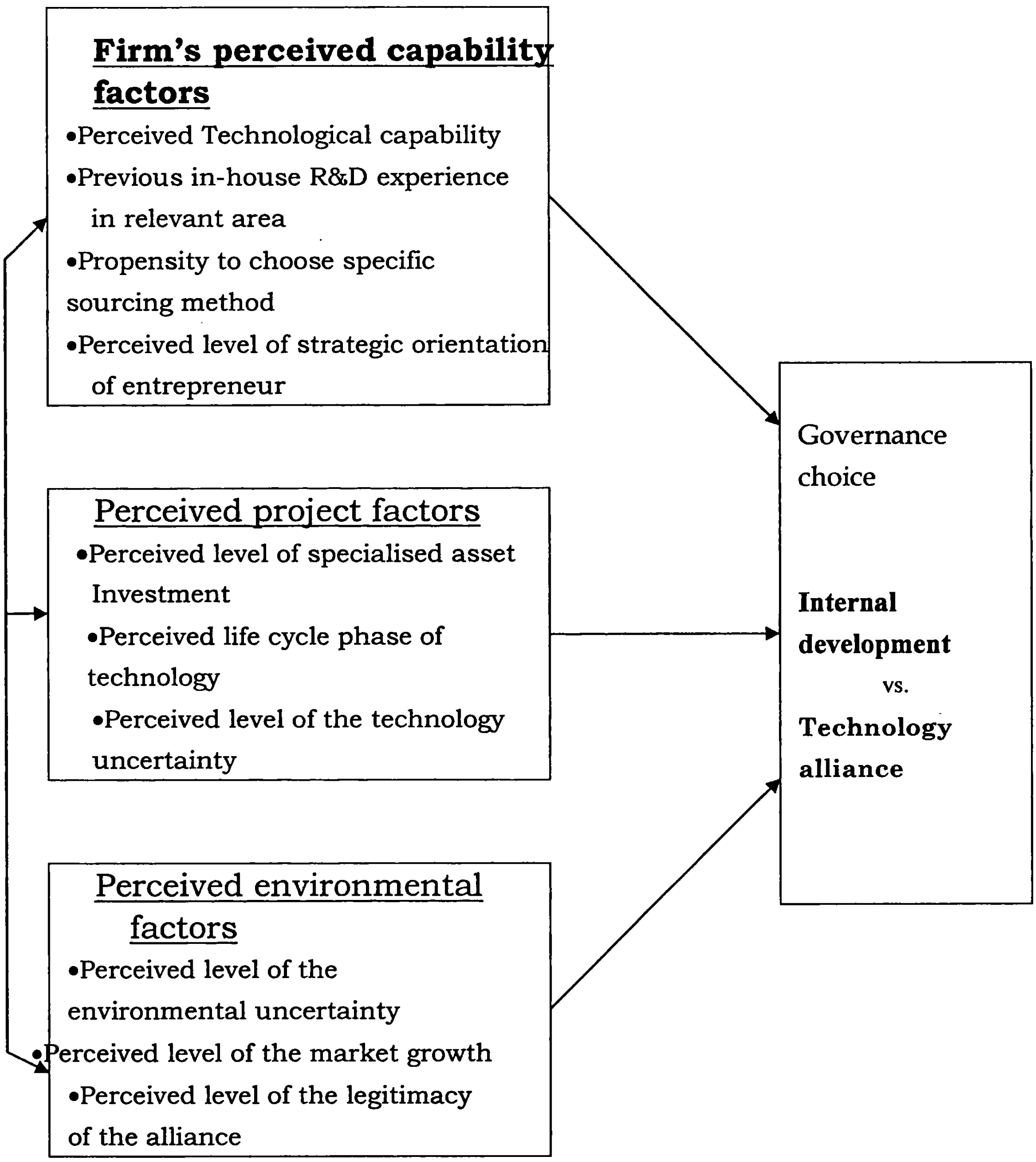
(Appendix 1) Two-stage contingency model



(Appendix 2.1) Determinants of stage 1



(Appendix 2.2) Summary of the variables in the 1st stage of decision-making

Variable name (variable)	Variable description
P1q2	Technology sourcing decision
P1q3ss (**X_1**)	Perceived level of the technological capability of a firm (5 items. 7 scale) •(P1q3_1) R&D facility •(P1q3_2) Management capability •(P1q3_3) New product (technology) development capability •(P1q3_4) R&D spending and investment •(P1q3_5) Number of patent or intellectual properties
Rdfr (**X_2**)	Proportion of R&D workforce (Total number of R&D workforces/Total number of employees)
P1q4 (**D_1**)	Previous in-house R&D experience in relevant area (1=Yes, 0=No)
PROPENSI (**X_3**)	Propensity to choose in-house development method (Total number of in-house development/Total number of tech development)
P1q5ss (**X_4**)	Perceived level of strategic orientation of the entrepreneur (6 items, 7 scale) •(P1q5_1) Leadership in R&D and technological innovation •(P1q5_2) Risk taking propensity •(P1q5_3) Reactiveness to the competitor's behaviour •(P1q5_4) Responsiveness to the industrial environment •(P1q5_5) Leadership in introducing technology/service/administrative technique •(P1q5_8) Strategic posture to the potential opportunity
P1q10s_1 (**X_{51}**)	Perceived level of specialized intangible asset investment (4 items, 7 scale) •(P1q10_2) Our firm has dedicated high level of professional know-how to the project •(P1q10_5) My firm has dedicated a major marketing commitment to the project •(P1q10_6) The project is very significant to the core competence of my firm •(P1q10_10) The level of the product (technology) sophistication is very high
P1q10s_2 (**X_{52}**)	Perceived level of the specialised tangible asset investment (3 items, 7 scale) •(P1Q10_1) Our firm has dedicated high levels of personnel to the project •(P1q10_3) Our firm has dedicated a significant amount of plant and equipment to the project •(P1Q10_4) Our firm has dedicated high levels of financial resources to the project

P1q10s_3 **(X53)**	Perceived level of redeployability of the invested asset (3 items, 7 scale) ▪(P1q10_7) Once people and equipment are redeployed for other use, their values are highly depreciated ▪(P1q10_8) It is very difficult to re-deploy the people and equipment for other use, once the project is stopped ▪(P1q10_9) The use of technological know-how acquired in the project is not much use to the other project
P1q13 **(X6)**	Perceived phase of the technology life cycle (1 items, 5 scale)
P1q11ss **(X7)**	Perceived level of technology uncertainty (5 items, 7 scale) ▪(P1q11_1) We were confident that this technology which the project will develop would achieve our market goal ▪(P1q11_2) We were confident that this technology would meet our technical expectation ▪(P1q11_3) We were confident that this technology would meet the customer demand ▪(P1q11_4) It is confident that this technology would work as it was intended and designed technologically ▪(P1q11_5) We were confident that the technology would be a commercial success
P1q6s_1 **(X81)**	Pperceived level of environmental uncertainty regarding industry and product market (5 items, 7 scale) ▪(P1q6_2) The frequency and extent of change in mode of production/service ▪(P1q6_3) The rate of product/technology/service obsolescence ▪(P1q6_6) The level of threat to the survival and well-being of the firm ▪(P1q6_7) General and overall industry competition level ▪(P1q6_8) The level of the control and manipulation of the environment
P1q6s_2 **(X82)**	Perceived level of the environmental uncertainty in terms of customer taste and competitor's action (2 items, 7 scale) ▪(P1q6_4) Predictability of the customer demand and taste ▪(P1q6_5) Predictability of the competitor's action
P1q7ss **(X9)**	Perceived level of the market growth (6 items, 7scale) ▪(P1q7_1) Customer demand is growing rapidly ▪(P1q7_2) Demand of the firm's product category is volatile ▪(P1q7_3) Product category growth is negligible (reversed) ▪(P1q7_4) Our playing industry field is a high growth market
P1q8ss **(X10)**	Perceived level of the legitimacy of the alliance (5 items, 7 scale) ▪(P1q8_1) Many firms in the industry seem to conceive that technology alliance is a strategic necessity for the success of technological innovation and competitive advantage of a firm

	▪(P1q8_2) We feel pressured or threatened when we hear the announcement that competitors or firms in the same industry launch a new technology alliance relationships ▪(P1q8_3) Strategic technology alliance has become routine and in fashionable in the telecommunications industry ▪(P1q8_4) It is most often observed in the industry that strategic alliance is formed with other objectives rather than developing new technology (e.g., name recognition, reputation spillovers, networking effect, corporate image, stock price increase) ▪(P1q8_5) We believe that strategic technology alliance would give a positive effect on the high tech firms and, if possible, we wish to form as many technology alliance as possible

(Appendix 2.3) Summary of the hypotheses in the 1st stage of decision-making

	Hypotheses	theoretical base of the prediction
H1-1	**(Perceived level of technological capability)** Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the decision-makers of Korean high-tech small firms **will choose in-house development** for new technology development project	TC
	Ceteris paribus, the greater the perceived level of perceived technological capability, the more likely that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development project	RB, SN
1-2	**(Proportion of R&D workers)** Ceteris paribus, the greater the proportion of R&D workers within the firm, the more likely that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project	TC
	Ceteris paribus, the greater the proportion of R&D workers within the firm, the more likely that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development project	RB
H1-3	**(Previous in-house R&D experience in relevant area)** Ceteris paribus, the more previous internal R&D experience in similar area, it is more likely that the decision-makers of Korean high-tech small firms **will choose in-house development** for new technology development project	TC, RB
H1-4	**(Propensity to choose specific technology sourcing mode (routine response))** Ceteris paribus, the more often the decision-makers of Korean high-tech small firms choose in-house development for new technology development previously, the greater the likelihood that they will choose the same method over again	TC, RB, INT
H1-5	**(Perceived level of strategic orientation of entrepreneur (entrepreneurial orientation)** Ceteris paribus, the greater the level of the entrepreneurial strategic orientation that the decision-makers of Korean high-tech small firm have, the greater the likelihood that they will choose technology alliance for new technology development project	RB, SN

1-6	**Perceived level of specialised asset investment (Technology/product specific asset)** Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project	TC
	Ceteris paribus, the greater the perceived level of specialised asset investment for the technology project, the more likely that the decision-makes of Korean high-tech small firms will choose technology alliance for new technology development project.	RB
1-7	**(Perceived phase of the technology life cycle (stage in technology life cycle)** Ceteris paribus, as the perceived phase of technology life cycle reaches the mature stage, the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project.	RB
	Ceteris paribus, as the perceived phase of technology life cycle reaches the mature stage, the decision-makes of Korean high-tech small firms will choose technology alliance for new technology development project	TC
1-8	**(Perceived level of the technology uncertainty)** Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose in-house development for new technology development project	TC
	Ceteris paribus, the greater the perceived level of technology uncertainty, the greater the likelihood that the decision-makers of Korean high-tech small firms **will choose technology alliance** for new technology development project	MP
1-9	**(Perceived level of the environmental uncertainty)** Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the decision-makes of Korean high-tech small firm will choose in-house development for new technology development project	TC
	Ceteris paribus, the greater the perceived level of the environmental uncertainty, the greater the likelihood that the decision-makers of high-tech small firms will choose technology alliance for new technology project	MP, RB

H1-10	**(Perceived level of the market growth)** Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose in-house development for the new technology development project	RD
	Ceteris paribus, the greater the perceived level of the market growth, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development project	MP
H1-11	**(Perceived level of the legitimacy of the alliance)** Ceteris paribus, the greater the perceived level of legitimacy of the alliance (pressure pushing firm to pursue cooperative strategy), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose technology alliance for new technology development project.	IST

(TC: transaction cost perspective; RB: resource based perspective; RD: resource dependence perspective; MP: market power perspective; IST: institutional perspective)

(Appendix 2.4) Summary of the operationalisation and measurement for each hypothesis

	Variable	Measurement items	Measure-ment scale	Adapted and modified researchers
H1-1	Perceived level of the technological capability	•R&D facilities •Management capability •New product (technology) development capability •R&D spending and investment •Number of patent or intellectual properties	Interval	Deed, et al (1998), Tidd & Trwhella (1997), Lee, et al. (2001)
H1-2	Perceived level of technological capability	Total number of R&D workforces divided by Total number of employees	Interval	Pisano (1990)
H1-3	Previous in-house R&D experience in relevant area	•1=Yes (if the firm has similar R&D experience in relevant area) •2=No (if the firm has no similar R&D experience in relevant area)	Categorical	Pisano (1990), White (2000)
H1-4	Propensity to choose spcific technology sourcing mode	Total number of technology development via in-house development divided by Total number of technology development	Interval	Steensma & Fairbank (1999)
H1-5	Perceived level of the strategic orientation of the entrepreneur	•Marketing-oriented vs. technological leadership-oriented •Proclivity to risk taking •Proactivness to the environment •Leadership in new product introduction •Diversity of service/product line •Reaction to the competitor •Type of strategic posture	Interval	Miller & Friesen (1982); Covin, et al (1990); Covin & Slevin (1990)

H1-6	Perceived level of specialised asset investment	•Our firm dedicated high levels of personnel to the project •Our firm dedicated high level of professional know-how to the project •Our firm dedicated a significant amount of plant and equipment to the project •Our firm dedicated high levels of financial resources to the project •My firm dedicated a major marketing commitment to the project •The project was very significant to the core competence of my firm •It was very difficult to re-deploy the equipment for other use, once the project is stopped •Once people and equipment were redeployed for other use, their values are highly depreciated •The use of technological know-how acquired in the project was not much use to the other project •The level of the product (technology) sophistication was very high	Interval	Heide&John (1990), Walker&Poppo (1991), Erramilli&Rao (1993), Ang (1998), Robert&gatignon (1998), Arino (2001)
H1-7	Perceived level of the life cycle phase of technology	•Introduction stage •Growth stage •Mature stage •Decline stage	Categorical (used as interval)	Brochoff (1992), Kurokawa (1997)
H1-8	Perceived level of the technology uncertainty	•We were confident that this technology would achieve our market goal •We were confident that this technology would meet our technical expectation •We were confident that this technology would meet customer demand •It was confident that this technology would work as it was intended and designed technologically •We were confident that this technology would be a commercial success	Interval	Weber & Walker (1984), Steensma & Fairbank (1999)
H1-9	Perceived level of the environmental uncertainty	•Frequency of strategic practice change •Pattern of strategic practice change •Technology obsolescence rate •Predictability of customer taste •Predictability of competitor •Survival rate in the environment •Competition rate •Political and technological environment	Interval	Miller & Friesen (1982); Bantel (1998)

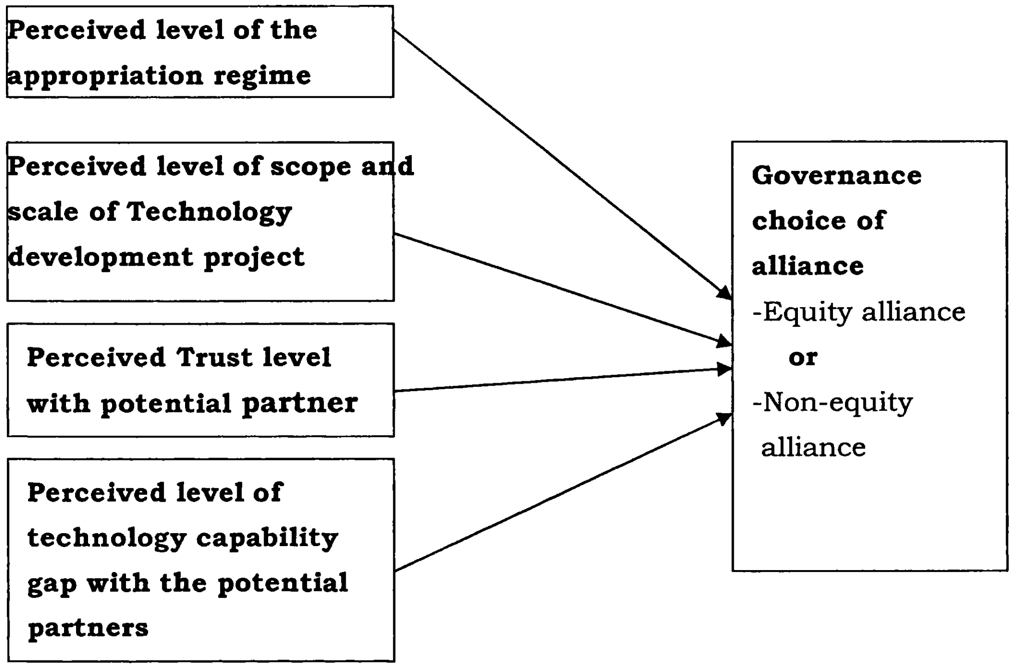
H1-10	Perceived level of the market growth	•Customer demand was growing rapidly •Demand of the firm's product category is volatile •Product category growth was rapidly growing •Our playing industry field was a high growth market •There were a lot of unexplored areas within the industry •There were rich opportunities in new investment and marketing in the field, thus we increase the financial spending	Interval	Mcdougal et al. (1994); Robertson&Gatignon (1997)
H1-11	Perceived level of the legitimacy for alliance	•Many firms in the industry seemed to conceive that technology alliance is a strategic necessity for the success of technological innovation and competitive advantage of a firm •We felt pressured or threatened when we hear the announcement that competitors or firms in the same industry launched a new technology alliance relationship •Strategic technology alliance became routine and in fashionable in the telecom industry •It was most often observed in the industry that strategic alliance is formed with other objectives rather than developing new technology •We believed that technology alliance would give a positive effect on the high-tech firms and, if possible, we wish to form as many alliance as possible	Interval	
H1-12	Perceived level of the appropriation regime	•Core product or technology of our firm is well protected by Korean patent law (reverse) •The intellectual property of our firm is likely be to be tacit and un-codifiable in nature •Misappropriation activity would be more likely to occur once the cooperation with the partner is initiated •It is difficult to state clearly the amount of knowledge exchanged with the cooperating partner •Disputes regarding technological leakage or free-riding are common in the industry	Interval	Jones, et al. (2000), Pisano(1990), Oliver (1990), Gulati (1995), White (2000), March-Chorda &Yague-parales (2000)

H1-13	Perceived scope of the project	•1=If alliance activity covers not limited to R&D but also production, marketing and supplying activity •2=If alliance activity covers only R&D	Categorical (used as interval)	Oxley (1997; 1999)
H1-14	Perceived scale of the project	•1=If alliance activity covers only one type of technology/product •2=If alliance activity covers more than two types of technology/product	Categorical (used as interval)	Oxley (1997; 1999)
H1-15	Perceived trust level with the potential partner	•We thought that partner firms were sincere in this attempt to meet our point of view •We thought that our partner firm could be trusted to make sensible decisions for the future of the alliance •We thought that our partner was an economically and socially efficient organization •We thought that our partner would be quite prepared to gain an advantage through deception (reversed) •We thought that our partner could be relied upon to keep the promises •We thought that our partner would lend us a helping hand if we run into problems •We thought that our partner would put us in danger due to negligence and carelessness on the job (reversed) •We thought that our partner has the skills and qualifications for the job	Interval	Cook & Wall (1980); Rao & Schmidt (1998)
H1-16	Perceived level of the technological capability gap with the potential partner	•Developing core technology •Modifying related technology •R&D workforces capability •R&D facilities •Ability to collect related technological information •Ability to absorb knowledge transferred or transmitted	Ineterval	Jone's et al. (1997); Arts and Brush (2000)

Controlling factor

H2	Perceived level of the governm ent support	•Tax incentive or deduction •Government fund and any other financial resource assistance •Government sponsored network association promoting information exchange among industry, universities and research institute •Governmental support for partner searching and evaluation and promoting international technology transfer	Interval	Beamish & Killing (1998)
H3	Perceived level of the financial costs of develop ment	•Average .. •High .. •Very high	Interval	Robertson & Gatignon (1997)

(Appendix 3.1) Determinants of stage 2



(Appendix 3.2) Summary of the variables in the 2nd stage of decision-making

Variable name (variable)	Variable description
P2q2	Mode of technology alliance
P2q9s_1 (**X_{111}**)	Perceived level of the appropriation regime by the influenced by codifiability and explicitness of the knowledge exchanged (2 items, 7 scale) •(P2q9_2) The intellectual property of our firm is likely to be tacit and uncodifiable in nature •(P2q9_4) It was difficult to state clearly the amount of knowledge exchanged with the cooperating partner
P2q9s_2 (**X_{112}**)	Perceived level of the appropriation regime influenced by the potential partner's free-riding and technology spillover (2 items, 7 scale) •(P2q9_3) Misappropriation activity would be more likely to occur once the cooperation with the partner is related •(P2q9_5) Dispute regarding technological leakage or free-riding are common in the industry
P2q10 (**D_2**)	Perceived scope of the technology development project •0= If the alliance activity covers only R&D •1= If the alliance activity covers not limited to R&D but also production, marketing and supplying activity
P2q11 (**D_3**)	Perceived scale of the technology development project • 0= If the alliance activity covers only one type of technology/product • 1= if the alliance activity covers more than two types of technology/product
P2q8s_1 (**X_{121}**)	Perceived trust level in terms of competence aspect (5 items, 7 scale) •(P2q8_2) We thought that our partner firm could be trusted to make sensible decisions for the future of the alliance •(P2q8_3) We thought that our partner was an economically and socially efficient organization •(P2q8_6) We thought that our partner would lend us a helping hand if we run into problems •(P2q8_7) We thought that our partner would not put us in danger due to negligence and carelessness on the job •(P2q8_8) We thought that our partner has the skills and qualifications for the job
P2q8s_2 (**X_{122}**)	Perceived trust level in terms of goodwill/forbearance aspect (2 items, 7 scale) •(P2q8_1) We thought that partner firms were sincere in this attempt to meet our point of view

	▪(P2q8_5) We thought that our partner could be relied upon to keep the promises
P2q12ss (**X13**)	Perceived technological capability gap with the potential partner (7 items, 7 scale) ▪(P2q12_1) Developing core technology ▪(P2q12_2) Modifying related technology ▪(P2q12_3) R&D workforces capability ▪(P2q12_4) R&D facilities ▪(P2q12_5) Ability to collecting related technological information ▪(P2q12_6) Ability to absorb knowledge transferred or transmitted ▪(P2q12_7) Utilising technological advisory group

(Appendix 3.3) Summary of the hypotheses in the 2nd stage of decision-making

	Hypotheses	**Prediction based on theoretical assumptions**
H1-12	**(Perceived level of appropriation regime)** Ceteris paribus, the weaker the perceived level of the intellectual property regime (appropriation regime), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose equity alliance	TC, RD
H1-13	**(Perceived scope of technology development project)** Ceteris paribus, the broader the perceived scope of cooperative activity (not only including R&D activities but also manufacturing, marketing and/or supply activities as well), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project	TC, RB
H1-14	**(Perceived scale of technology development project)** Ceteris paribus, the broader the perceived scale of cooperative activity (not only limited one technology but also covering range of products/technologies), the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project	TC, RB
H1-15	**(Perceived trust level with the potential partners)** Ceteris paribus, the stronger the perceived trust level with the potential partner, the greater the likelihood that the decision-makes of Korean high-tech small firms will choose non-equity alliance for new technology development project	SN
H1-16	**(Perceived level of the technological capability gap with the potential partner)** Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an non-equity alliance for new technology development project.	SN, RB
	Ceteris paribus, the greater the perceived level of technological capability gap with the partnering firm, the greater the likelihood that the decision-makers of Korean high-tech small firms will choose an equity alliance for new technology development project.	MP

(TC: transaction cost perspective; RB: resource based perspective; SN: social network perspective; MP: market power perspective)

(Appendix 3.4) The result of the calculation from the logistic regression

Following is the logistic regression equation model that is used in the stage 1.

Logit^ = 6.391 + 2.430X2 - 0.431X4 - 0.332X53 - 0.415X7 - 0.424X10

$$\text{Logit}^{\wedge} = 6.391 + 2.430X_2 - 0.431X_4 - 0.332X_{53} - 0.415X_7 - 0.424X_{10}$$

where

X_2: Proportion of R&D workers

X_4: Perceived level of strategic orientation of the entrepreneur

X_{53}: Perceived level of the redeployability of the invested assets

X_7: Perceived level of technology uncertainty

X_{10}: Perceived level of the legitimacy of the alliance

For the simplicity of calculation, the variations of the factors are classified into three different levels (low, medium, high). Then, the following logit-value table for each variable can be identified:

Value of the X_i	$logit_i$ (mode=1) for X_2	$logit_i$ (mode=1) for X_4	$logit_i$ (mode=1) for X_{53}	$logit_i$ (mode=1) for X_7	$logit_i$ (mode=1) for X_{10}
*Highest Score	2.430	-3.0170	-2.3240	-2.9050	-2.9680
*Medium Score	1.2150	-1.5085	-1.1620	-1.4525	-1.4840
*Lowest Score	0	-0.4310	-0.332	-0.4150	-0.4240

*Highest score indicates 7, medium score 3.5 and lowest score 1 as all variables are measured in 7 Likert-scale. However, in X_2, high score indicates 1, medium score 0.5 and low score 0 because X_2 is measured from 0 to 1 continuous scale.

Transforming the logit value into the probability of choosing in-house development for firm *i* (P_i (mode=1)) produces the following result.

	P_i (mode=1) for $\mathbf{X_2}$	P_i (mode=1) for $\mathbf{X_4}$	P_i (mode=1) for $\mathbf{X_{53}}$	P_i (mode=1) for $\mathbf{X_7}$	P_i (mode=1) for $\mathbf{X_{10}}$
Highest Score	0.9191	0.047	0.0891	0.0519	0.0488
Medium Score	0.771	0.1811	0.2383	0.1896	0.1848
Lowest Score	0.5	0.3939	0.4177	0.3977	0.3956

The table above shows that when the perceived level of the technological capability measured by the proportion of R&D workers (X_2) is lowest (X_2=1), the probability for respondent *i* to choose in-house development is about 50 %. However, when the level increases to the highest (X_2=7), the probability for respondent *i* to choose in-house development increases by 42 %, reaching almost 92 %. On the other hand, for instance, when the perceived level of the redeployability of the invested assets is lowest (X_{53}=1), the probability for respondent *i* to choose in-house development is about 42 %, but as the level increases to the highest value (X_{53}=7), the probability drops by 32.8 % reaching only 8.9 %.

To create a solid basis, the decision-makers need to assess the above five significant factors together not individually, when they are actually facing decision-making situations. In other words, what would be the probability of choosing in-house development over technology alliance when the respondents are considering all determinants simultaneously? For instance, what would the respondent *i* be likely to choose when it has the highest score in X_2 (the level of technological capability) and X_{53} (Perceived level of the redeployability of the invested assets) simultaneously? As we see from the calculation above, the highest score of X_{53} favours the in-house development while the highest score of the latter favours technology alliance under this situation. To answer this question, we simply insert relevant information, as we did above, to the logistic regression, then transform the logit value into the probability model of an occurrence.

Supposing that three individual firms have the following combination of perceived independent values from the identified determinants, what will be the probability of them choosing in-house development over technology alliance?

Factor	**Firm A**	**Firm B**	**Firm C**
X_2	0.7	0.5	0.2
X_4	6	5	2
X_{53}	6	3	3
X_7	6	4	4
X_{10}	6	4	2

X2: (0= no R&D workers & 1= full R&D workers)

X4: (1=least perceived level of entrepreneur strategic orientation & 7= highest perceived level)

X53:(1=least perceived level of the redeployability of the invested assets & 7=highest perceived level)

X7: (1= least perceived level of technology uncertainty & 7= highest perceived level)

X10: (1= least perceived level of the legitimacy of the alliance & 7= highest)

For firm A, the logit value will be:

$$\textbf{Logit}^\wedge = 7.202 + 2.404(0.7) - 0.386(6) - 0.321(6) - 0.503(6) - 0.353(6)$$
$$= 7.202 + 1.6828 - 2.3160 - 1.9260 - 3.0180 - 2.1180$$
$$= -0.4932$$

Then P_A (mode=1(in-house development)) = $1/(1 + e^{-(-0.4932)})$ = 1/2.64 = 0.38.

We can say that the probability of firm A choosing in-house development will be 38 % while the probability choosing technology alliance would be 62 %.

For firm B, the logit value will be

$$\textbf{Logit}^\wedge = 7.202 + 2.404(0.5) - 0.386(5) - 0.321(3) - 0.503(4) - 0.353(4)$$
$$= 7.202 + 1.2020 - 1.930 - 0.9630 - 2.0120 - 1.4120$$
$$= 2.0870$$

Then P_B (mode=1(in-house development)) = $1/(1 + e^{-(2.0870)})$ = 1/1.1240 = 0.8897. We can say that the probability of firm B choosing in-house development will be about 89 % while the probability of choosing technology alliance would be 11 %.

For firm C, the logit value will be

$$\textbf{Logit}^\wedge = 7.202 + 2.404(0.2) - 0.386(2) - 0.321(3) - 0.503(4) - 0.353(2)$$
$$= 7.202 + 0.4848 - 0.7720 - 0.9630 - 2.0120 - 0.7060$$
$$= 3.2858$$

Then P_C (mode=1(in-house development)) = $1/(1 + e^{-(3.2858)})$ = 1/1.0374 = 0.9640. We can say that the probability of a firm choosing in-house development will be about 96 % while the probability of choosing technology alliance would be 4 %.

The impression from this analysis is that, unless all the perceived levels from the factors $\mathbf{X_4}$ (perceived level of strategic orientation of the entrepreneur) , $\mathbf{X_{53}}$ (perceived level of the redeployability of the invested assets), $\mathbf{X_7}$ (perceived level of technology uncertainty), and $\mathbf{X_{10}}$ (perceived level of the legitimacy of the alliance) are relatively high and perceived level from the factor $\mathbf{X_2}$ (perceived level of the technological capability in terms of proportion of R&D workers) is relatively small simultaneously, it is less likely that firms will choose technology alliance. From this research, this would hardly appear to be the case within this research finding. Thus, it is clear why the number of responding firms choosing technology alliance is much smaller than those choosing in-house development.

Following is the logistic equation model that is used in stage 2.

Logit^ = -3.806 - 2.586 D_2 + 2.022 X_{121}

where

D_2: Perceived scope of the technology development project

X121: Perceived trust level of the partner's competence

Supposing four individual firms have the following combination of perceived independent values, what will be their probability of choosing non-equity alliance?

Factor	Firm A	Firm B	Firm C	Firm D	Firm E
D_2	0	0	1	1	1
X121	1	2	4	6	1

For firm A, the logit value will be:

Logit^ = -3.806 - 2.586 (0) + 2.022 (1)

= -1.7840

Then P_C (mode=1(equity alliance)) = 1/(1 + $e_{-(-1.7840)}$) = 1/6.9536= 0.1439.

The probability of firm A choosing non-equity alliance is about 14 %.

For firm B, the logit value will be:

Logit^ = -3.806 - 2.586 (0) + 2.022 (2)

= 0.2380

Then P_B (mode=1(equity alliance)) = 1/(1 + $e_{-(-0.2380)}$ = 1/1.7882 = 0.5593.

The probability of firm B choosing non-equity alliance is about 56 %.

For firm C, the logit value will be:

Logit^ = -3.806 - 2.586 (1) + 2.022 (4)

= 1.6960

Then P_C (mode=1(equity alliance)) = 1/(1 + $e_{-(1.6960)}$) = 1/1.1834 = 0.84.

The probability of firm C choosing non-equity alliance is about 84 %.

For firm D, the logit value will be:

Logit^ = -3.806 - 2.586 (1) + 2.022 (6)

= 5.7436

Then P_D (mode=1(equity alliance)) = 1/(1 + $e_{-(5.7436)}$) = 1/1.003= 0.9970.

The probability of firm D choosing non-equity alliance is about 99 %.

Lastly, for firm E, the logit value will be:

Logit^ = -3.806 - 2.586 (1) + 2.022 (1)

= -4.370

Then P_E (mode=1(equity alliance)) = 1/(1 + $e_{-(-4.370)}$) = 1/80.04= 0.0125.

The probability of firm E choosing non-equity alliance is about 1.3 %.

(Appendix 4) Questionnaire (English text version)

I. General question about the firm

1. What is the name of your firm? ( )

2. General background of yourself

What is your position in the firm?	
What is your age?	20-30 30-40 40-50 51-60 over 60
What is your final level education level?	High school Undergraduate Post-graduate

3. General background of your firm

When was your firm established?	
What is the type of your firm? Please circle in relevant item	KOSDAQ listed firm, Non-listed firm
How many employees does your firm have (as of now)?	
How many R&D workforces does your firm have (as of now)?	
What was the total sales in the last fiscal year?	Won
What was the EBIT (Earning Before Income Tax) in the last fiscal year?	Won
What is the percentage of R&D spending per total sales in the last fiscal year?	%

4. What is the main business area of your firm? Tick ✓ in the relevant space.

Telecommunication equipment manufacturing	
Industrial communication equipment manufacturing	
Communication related household electrical appliances	
Internet/solution	
Software	
Semiconductor/accessories(parts)/material	
Etc. (please, specify)	

5. Please, identify the ownership structure of your firm.

Who is the 1st major shareholder?	( )
Who is the 2nd major shareholder?	( )
Who is the related company?	( )

6. How many officially registered intellectual properties does your firm possess now?

Patent	Utility model	Trade secret	Trademark	Programme	Etc. (Please. specify)
( )	( )	( )	( )	( )	( )

II. The aim of this section is to investigate the technology sourcing decision about the most significant and representative technological innovation project. Please, respond to all questions by considering the situation when the technology sourcing decision was made, not at the present moment.

☞"The most significant and representative technological innovation project" is defined as:

1. The project aimed at developing products or technology related to electronic appliances and communications equipment in the telecommunications industry

2. The project aimed at technological innovation and breakthrough rather than modification of the existing product or technology

3.The project aimed at developing the major product or technology of your firm in terms of market recognition, total sale, profitability and core technological capability

4.The project only conducted during the last four years (1.1.1998-31.12.2001)

5.Any R&D project related to the above condition

1. Considering the condition above, please answer the questions below.

When did your firm start the project?	(mm / yy)
When was the project completed or when will it be completed?	(mm / yy)
Please briefly describe the content of the project	( )

2. What types of governance structure did your firm choose to conduct the project? Tick ✓ in the appropriate space.

In-house development via internal technological resources or via acquisition of other firm(s)	( )
Cooperation with other firm(s) or institute(s) (e.g., strategic alliance, joint venture or contract agreement, excluding one-time informal cooperation arrangement or any other arrangement only for marketing/distribution, capital gain and financial sourcing)	( )

3. What was the technological capability level of your firm like when it started the project?

R&D workforces	( )
R&D investment	( )

4. How would you evaluate your technological capabilities in terms of items stated below, compared with leading firms (either in domestic or foreign ones) in the same industry? Please circle the number in each scale that best approximates its actual conditions.

	Items	much less similar much more

Q1	R&D facilities	1	2	3	4	5	6	7
Q2	Number of R&D workforces	1	2	3	4	5	6	7
Q3	New product(technology) development capability	1	2	3	4	5	6	7
Q4	R&D spending and investment	1	2	3	4	5	6	7
Q5	Number of patent or intellectual properties	1	2	3	4	5	6	7

5. Has your firm previously conducted a technology development project in a similar or related area, previously? Tick ✓ in the appropriate item.

Yes	( )
No	( )

6. Before launching the project, what was your firm's typical technology sourcing strategy for new technology development? Put the number of cases in each appropriate space. If there is no case, please put 0 in the space(s).

Internal or in-house development	( )
Outsourcing, allying or cooperation with other firms	( )
We didn't conduct any technology development project previously	( )

7. What was the financial status of your firm? (If you cannot be exact, please give your best estimation) (Unit: won)

Equity	Won
Liabilities	Won
Asset	Won

8. Each of the following items consists of a pair of statements which represent the two extremes on aspects of entrepreneurship that account for the time when the project was initiated. Please circle the number in each scale that best approximates its actual conditions.

Q1	Our firm made a strong emphasis on the marketing of tried and true products or services	1 2 3 4 5 6 7	Our firm make a strong emphasis on R&D, technological leadership and innovations
Q2	Our firm has a strong proclivity for low-risk projects	1 2 3 4 5 6 7	Our firm has a strong proclivity for high-risk projects
Q3	Our firm typically responds to actions which competitors initiate	1 2 3 4 5 6 7	Our firm typically initiated actions which competitors then respond to
Q4	Owing to the nature of the environment, it is best to explore it via timid, incremental behaviour	1 2 3 4 5 6 7	Owing to the nature of the environment, bold wide-ranging acts are necessary to achieve the firm's objectives
Q5	Our firm is very seldom the first business to introduce new	1 2 3 4 5 6 7	Our firm is very often the first business to introduce new

	products/services, administrative techniques, operating technologies, etc.		products/services administrative techniques, operating technologies, etc.
Q6	Our firm had no new lines of products or services during the past 5 years	1 2 3 4 5 6 7	Our firm had very many new lines of products or services
Q7	Our firm typically seeks to avoid competitive clashes, preferring a "live-and-let-live" posture	1 2 3 4 5 6 7	Our firm typically adopt a very competitive, undue-the-competitor" posture
Q8	Our firm typically adopts a cautious, "wait-and-see posture in order to minimise the probability of making costly decision	1 2 3 4 5 6 7	Our firm typically adopts a bold, aggressive posture in order to maximise the probability of exploiting potential opportunities

9. Each of the following items consists of a pair of statements which represent the two extremes on aspects of industrial environment that account for the time when the project was initiated. Please circle the number in each scale that best approximates its actual conditions.

Q1	Our firm must rarely change its marketing practices to keep up with the market and competitor	1 2 3 4 5 6 7	Our firm must change its marketing practices extremely frequently (e.g., semi-annually)
Q2	The rate at which products/services are becoming obsolete in the industry is very slow	1 2 3 4 5 6 7	The rate of obsolescence is very high
Q3	The production/service technology is not subject to very much change and is well established	1 2 3 4 5 6 7	The modes of production/service change often and in a major way
Q4	Demand for product and consumer tastes are fairly easy to forecast	1 2 3 4 5 6 7	Consumer demand and tastes are almost unpredictable
Q5	Actions of competitors are quite easy to predict	1 2 3 4 5 6 7	Actions of competitors are unpredictable
Q6	The environment is very safe and Is of little threat to the survival And well being of the firm	1 2 3 4 5 6 7	The environment is very risky and one false step could mean my firm's undoing
Q7	There is no severe competition with other firms	1 2 3 4 5 6 7	There is very severe competition with the other firms
Q8	Our firm can control and manipulate the environment to its own advantage, such as a dominant firm has in an industry with little competition and few hinderances	1 2 3 4 5 6 7	A dominant environment in which our firm's initiatives count for very little when up against the tremendous political, technological or competitive forces

10. To what extent do you agree with the following statements regarding the growth rate of the industry you are in? Please circle the number in each scale that best approximates its actual conditions.

	Items	Strongly disagree			neutral		Strongly agree	
Q1	Customer demand is growing rapidly	1	2	3	4	5	6	7
Q2	Demand of the firm's product category is volatile	1	2	3	4	5	6	7
Q3	Product category growth is negligible (reversed)	1	2	3	4	5	6	7
Q4	Our playing industry field is a high growth market	1	2	3	4	5	6	7
Q5	There are a lot of unexplored areas within the industry	1	2	3	4	5	6	7
Q6	Rich in investment and marketing opportunities	1	2	3	4	5	6	7

11. To what extent do you agree with the following statements regarding the institutional legitimacy of the strategic alliance? Please circle the number in each scale that best approximates its actual conditions.

	Items	Strongly disagree			neutral		Strongly agree	
Q1	Many firms in the industry seem to conceive that technology alliance is a strategic necessity for the success of technological innovation and competitive advantage of a firm	1	2	3	4	5	6	7
Q2	We feel pressured or threatened when we hear the announcement that competitors or firms in the same industry launch a new technology alliance relationships	1	2	3	4	5	6	7
Q3	Strategic technology alliance has become routine and in fashionable in the telecommunications industry	1	2	3	4	5	6	7
Q4	It is most often observed in the industry that strategic alliance is formed with other objectives rather than developing new technology (e.g., name recognition, reputation spillovers, networking effect, corporate image, stock price increase)	1	2	3	4	5	6	7
Q5	We believe that strategic technology alliance would give a positive effect on the high tech firms and, if possible, we wish to form as many technology alliance as possible	1	2	3	4	5	6	7

12. To what extent do you agree with the following items regarding government policy or effort to promote technological cooperation? Please circle the number in each scale that best approximates its actual conditions.

	Items	Strongly un-satisfy			neutral		Strongly satisfy	
Q1	Tax incentive or deduction	1	2	3	4	5	6	7

Q2	Government fund and any other financial Resource assistance	1 2 3 4 5 6 7
Q3	Government sponsored network association promoting information exchange among industry, universities and research institute	1 2 3 4 5 6 7
Q4	Governmental support for partner searching and evaluation and promoting international technology transfer	1 2 3 4 5 6 7
Q5	Relaxing anti-trust law and promoting intellectual property policy	1 2 3 4 5 6 7
Q6	Supporting human resources, technological training and physical facilities	1 2 3 4 5 6 7
Q7	Etc.(*Please, specify*)	1 2 3 4 5 6 7

13. To what extent do you agree with the following statements regarding the specificity level of assets invested in the project? Please circle the number in each scale that best approximates its actual conditions.

	Items	Strongly disagree		neutral		Strongly agree		
Q1	Our firm has dedicated high levels of personnel to the project	1	2	3	4	5	6	7
Q2	Our firm has dedicated high level of professional know-how to the project	1	2	3	4	5	6	7
Q3	Our firm has dedicated a significant amount of plant and equipment to the project	1	2	3	4	5	6	7
Q4	Our firm has dedicated high levels of financial resources to the project	1	2	3	4	5	6	7
Q5	My firm has dedicated a major marketing commitment to the project	1	2	3	4	5	6	7
Q6	The project is very significant to the core competence of my firm	1	2	3	4	5	6	7
Q7	It is very difficult to re-deploy the people and equipment for other use, once the project is stopped	1	2	3	4	5	6	7
Q8	Once people and equipment are redeployed for other use, their values are highly depreciated	1	2	3	4	5	6	7
Q9	The use of technological know-how acquired in the project is not much use to the other project	1	2	3	4	5	6	7
Q10	The level of the product (technology) sophistication is very high	1	2	3	4	5	6	7

14. To what extent do you agree with the following statements regarding your expectation of technology (product) that your firm intended to developed from the project? Please circle the number in each scale that best approximates its actual conditions.

	Items	Strongly disagree	neutral	Strongly agree

Q1	We were confident that this technology which the project will develop would achieve our market goal	1	2	3	4	5	6	7
Q2	We were confident that this technology would meet our technical expectation	1	2	3	4	5	6	7
Q3	We were confident that this technology would meet customer demand	1	2	3	4	5	6	7
Q4	It is confident that this technology would work as it was intended and designed technologically	1	2	3	4	5	6	7
Q5	We were confident that this technology would be a commercial success	1	2	3	4	5	6	7

15. Considering R&D investment, production and personnel expenses, to what extent did you estimate the developing cost of a new product or technology? Please, circle the number in each scale that best approximates its actual conditions.

Average		high		Very high		
1	2	3	4	5	6	7

16. As far as the core technology of your new product is concerned, at what phase of the life cycle do you think the product was? Please, tick ✓ in the appropriate space.

Completely new technology (we are the first developer)	( )
Introductory phase (The product/technology is relatively new in the market)	( )
Growth phase (Similar product/technology is introducing in the market)	( )
Mature phase (many similar product/technology is already introduced in the market)	( )
Declining phase (another technology was about to replace it)	( )

III. This section is only for the firm choosing technology alliance as a technology sourcing decision. Please respond to all questions by considering the situation when the technology alliance decision was made, not at the present moment.

1. What types of technology alliance have you chosen for the project? Please tick ✓ in appropriate space and describe the specific alliance mode.

Equity alliance (e.g., equity joint venture, minority equity investment, equity sharing, research corporations)	( )→(mode?)
Non-equity alliance (e.g. licensing, sub-contracting, cross-licensing, second sourcing, franchising, R&D contract agreement, technology sharing)	( )→(mode?)

2. Please identify the partnering firm.

Name of the partner firm	
Partner's major business area	
Partner's nationality	

3. What type of partner is it in the value chain? Please, tick ✓ in the appropriate space.

Supplying firm	
Customer firm	
Competitor	
A firm that is in the non-related industry with ours	
Public or governmental research institute(s)	
Universities	
Etc. (*please specify*)	

4. According to the annual sales and employees number, how do you evaluate the size of the partner? Please, Tick ✓ in the appropriate space.

1. Much smaller than our firm	( )
2. Slightly smaller than our firm	( )
3. About the same with our firm	( )
4. Slightly bigger than our firm	( )
5. Much bigger than our firm	( )

5. Had your firm involved in any other formal or informal cooperative relationship for any purpose with this particular partner before the project?

Yes	No
( )	( )

6. If yes, how long? ( )

7. According to your understanding and impression, to what extent do you agree with the following statements regarding your partner and their attitude toward the project?

	Items	Strongly disagree			neutral		Strongly agree	
Q1	We thought that partner firms were sincere in this attempt to meet our point of view	1	2	3	4	5	6	7
Q2	We thought that our partner firm could be trusted to make sensible decisions for the future of the alliance	1	2	3	4	5	6	7
Q3	We thought that our partner was an economically and socially efficient organization	1	2	3	4	5	6	7

Q4	We thought that our partner would be quite prepared to gain an advantage through deception (reversed)	1	2	3	4	5	6	7
Q5	We thought that our partner could be relied upon to keep the promises	1	2	3	4	5	6	7
Q6	We thought that our partner would lend us a helping hand if we run into problems	1	2	3	4	5	6	7
Q7	We thought that our partner would not put us in danger due to negligence and carelessness on the job	1	2	3	4	5	6	7
Q8	We thought that our partner has the skills and qualifications for the job	1	2	3	4	5	6	7

8. How did you evaluate the protectiveness of your intellectual properties from the potential partner? Please circle the number in each scale that best approximates its actual conditions.

	Items	Strongly disagree		Neutral		Strongly agree		
Q1	Core product or technology of our firm is well protected by Korean patent law	1	2	3	4	5	6	7
Q2	The intellectual property of our firm is likely be to be tacit and un-codifiable in nature	1	2	3	4	5	6	7
Q3	Misappropriation activity would be more likely to occur once the cooperation with the partner is initiated	1	2	3	4	5	6	7
Q4	It is difficult to state clearly the amount of Knowledge exchanged with the cooperating partner	1	2	3	4	5	6	7
Q5	Disputes regarding technological leakage or free-riding are common in the industry	1	2	3	4	5	6	7

9. What was the scope of the technology alliance agreement? Please, tick ✓in the appropriate space.

The scope of technology alliance covered marketing, distribution, promotion and sales, in addition to developing new technology or product	( )
The scope of technology alliance only covered new technology or product development	( )

10. What was the range of product or new technology intended to develop? Please tick ✓ in the appropriate space.

The range of product or technology covered by the agreement is few or more	( )
The range of product or technology covered by the agreement is only a single one	( )

11. How did you evaluate the technological capability gap with your partner in terms of the following items? Please, circle the number in each scale that best approximates its actual conditions.

	Items	Much Inferior		similar		much superior		
Q1	Developing core technology	1	2	3	4	5	6	7
Q2	Modifying related technology	1	2	3	4	5	6	7
Q3	R&D workforces capability	1	2	3	4	5	6	7
Q4	R&D facilities	1	2	3	4	5	6	7
Q5	Ability to collecting related technological information	1	2	3	4	5	6	7
Q6	Ability to absorb knowledge transferred or transmitted	1	2	3	4	5	6	7

IV. The aim of this section is to identify the motivation, diversity and partner typology of the technological cooperation activities and how these have changed as the stages of technological development of individual firms advances.

(☞Here, technological cooperation activities are meant to be a partnerships between two independent entities which seek to leverage and share technological resources or know-how of each in order to develop substantial technological innovations and new product(process) development.
Cooperation only for product modification, line extensions of existing products, sales and marketing enhancement and mergers and acquisitions are excluded here. Technological cooperation activities include a wide range of formal and informal arrangement. Specific examples are identified in the question 3 and 5 below.)

1. Considering the development stage of your major product (technology or service) defined in the table below, what is the current technological phase of your firm? Please tick ✓ in the appropriate space.

	Attribute of development stage
Stage 1: Introduction	•Products (technology, service) are unfamiliar to many potential users and industry-wide demand is beginning to grow
Stage2: Growth	•Total industry-side demand for products (technology, service) is growing at a rate of 10% or more annually
Stage3: Maturity	•Products (technology, service) are familiar to the vast majority or prospective users and industry-wide demand is relatively stable
Stage4: Decline	•Total industry-wide demand for products (technology, service) is decreasing at a more or less steady rate

(stage1: Introduction)	(Stage2: Growth)	(Stage3: Maturity)	(Stage4: Decline)

2. Please put the number (frequency) of formal technology collaboration arrangements that your

firm have conducted during the stage you indicated above.

(☞In case you cannot clearly recall specific official alliance arrangements due to significant time elapse, please give your best estimation for each stage)

Equity alliance	joint venture with foreign firm	
	Joint venture with domestic firm	
	Minority equity investment	
	Etc.( )	
Non-equity alliance	Licensing from domestic firm	
	Licensing from foreign firm	
	Co-production agreement with domestic competitor	
	Co-production with foreign competitor	
	Research pact with domestic competitor	
	Research pact with foreign competitor	
	Joint development agreement with domestic customer	
	Joint development agreement with foreign customer	
	R&D contract with research institute	
	Research pact with research institute	
	R&D contract with universities	
	Research pact with universities	
	Etc. ( )	

3. Please put the number of informal technology collaboration arrangement during the stage you indicated above.

(☞In case you cannot clearly recall specific informal alliance arrangements due to significant time elapse, please give your estimation for each stage)

(Example)

None	2-5 times	5-10 times	10-20 times	Over 20 times
1	2	3	4	5

Support from governmental body	Supporting technical information					
	Supporting or lending technical facilities	1	2	3	4	5
	Supporting with technical experts	1	2	3	4	5
	Supporting for patent registration	1	2	3	4	5
	Human resource education	1	2	3	4	5
Technical advice from domestic supplier		1	2	3	4	5
Technical advice from foreign supplier		1	2	3	4	5
Exchanging technical information with customers		1	2	3	4	5
Exchanging technical information with domestic competitors		1	2	3	4	5
Exchanging technical information with foreign competitors		1	2	3	4	5
Etc. ( )		1	2	3	4	5

4. How do you evaluate the effect of formal and informal collaboration on the following technological capability of your firm? Please circle the number in each scale that best approximates its actual conditions.

	Items	Not Improved			Moderated			Very Improved
Q1	Technology choice capability	1	2	3	4	5	6	7
Q2	Modification capability of existing technology	1	2	3	4	5	6	7
Q3	R&D, design and innovation capability	1	2	3	4	5	6	7
Q4	Commercialisation and manufacturing capability	1	2	3	4	5	6	7
Q5	Absorptive and learning capability	1	2	3	4	5	6	7
Q6	Over all technological capability	1	2	3	4	5	6	7

(Appendix 5) Questionnaire in Korean version (that were used for data collection for population group)

「벤처기업 기술제휴」에 관한 설문 조사

안녕하십니까?

저희는 ㈜리스피아르 조사연구소입니다. 금번 저희 연구소에서는 영국의 Centre of Economic Performance 가 추진하는 21 개국을 대상으로 한「 **벤처기업 기술제휴」에 대한 조사를** 실시하고 있습니다. 응답해 주신 의견은 벤처기업들의 현상황을 이해하는데 도움이 될 것입니다. 또한 수집된 자료는 **통계처리이외의 목적으로는 활용되지 않을 것임을 약속** 드립니다. 감사합니다. 2002 년 12 월 일

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Tel. 02-323-3832 / fax. 02-323-4037

Part Ⅰ. 귀사의 일반적인 사항에 관한 질문입니다.

문 1. 기업체 개요

1. 업체명	( )		2. 설립년도	년 월
3.기업형태 ( )		①상장회사 ②비상장회사	4. 직원 수 (2002 년 11 월)	( )명
5. 연구개발 인력수(2002 년 11 월)		( )명	6. 총 매출액 (2001 년)	( )원
7. 지난 회계연도 매출액 대비 영업 이익 (2001 년 기준)		( )원	8. 총매출액 내 연구 개발비 (2001 년 기준)	( )원

문 2.귀사의 주력 사업분야는 무엇입니까? (매출액을 기준으로 2 개까지 기입 가능) ( ) ( )

기타는 구체적으로 서술해주시기 바랍니다.

.정보통신기기	2. 산업전자	3. 생활전자	4. 인터넷 솔루션
. 소프트웨어	6. 반도체/부품/소재	7. 기타:	

문 3 귀사의 소유형태에 관한 질문입니다.

1) 1 대 주주 ( ) 2) 2 대 주주 ( )

3) 관계사 ( ) ( ) ( )

문 4. 현재 귀사가 보유하고 있는 (등록된) 지적재산권은 몇 건입니까?

특허	실용신안	의장	상표	프로그램등록	기타
( )건	( )건	( )건	( )건	( ) 건	( )건

Part 2. 정보통신 관련 기술개발 프로젝트에 관한 사항입니다

다음은 귀사가 최근 3년간 수행하였던 전자, 정보통신 관련 기술개발 project 들 중 가장 핵심적이고 대표적인 것 하나를 선택하여서, 그 **프로젝트를 기준으로** 다음사항에 대해 답변해 주십시오.

문 1. 핵심 기술개발 프로젝트 시기와 내용에 대해 답해 주십시오

1. 시작시기: 년 월	2. 종료시기 년 월
3. 프로젝트 내용:	

문 2. 프로젝트 수행 방식에 해당하는 번호를 써 주십시오 ( )

1) 타기업 인수 또는 독자적인 방식 2) 상호 자본참여 및 협력/ 제휴 방식

문 3. 프로젝트 수행 당시, 귀사의 연구개발 투자정도는?

1. 총 연구개발인력 (R&D workforces)	( )명	당시 총 직원 수	( )명
2. 연구개발비 투자규모	( )원	당시 총 매출	( )원

문 4.동종업계 선두기업(국내외 모두포함)과 비교하여, 귀사의 연구개발능력은 어느 정도 수준 이었습니까? 해당하는 번호를 써 주십시오

훨씬 취약 보통 훨씬 우위

1 ------ 2 -------- 3 ------- 4 -------- 5 ------- 6------- 7

측정항목	해당번호	측정항목	해당번호
1 연구 개발시설 측면	( )	2 연구개발인력 측면	( )
3 신제품 개발 능력 측면	( )	4 연구 개발비 투자 측면	( )
5 특허 보유건 수 측면	( )		

문 5. 그 프로젝트와 비슷한 또는 관련성이 깊은 프로젝트를 예전에 수행한 적이 있습니까? ( )

1) 그렇다. 수행한 적이 있다. 2) 아니다. 처음 해 보는 프로젝트였다.

문 6 .기술개발 당시 귀사의 재무상태는? (기억에 확실치 않을 경우 대략적 추정치를 기입하여 주십시오.)
(단위: 원)

① 자본 (원)	② 부채 (원)	③ 자산 (원)

문 7.프로젝트 추진당시 귀사의 지위나 상태를 고려, 다음 각 질문들의 왼쪽과 오른쪽 항목들 가운데 어느 쪽에 더 가까운지 해당하는 번호를 써 주십시오.

(1= 왼쪽 항목에 가장 근접, 4= 양쪽 항목의 중간정도, 7= 오른쪽 항목에 가장 근접)

1---2---3---4---5---6---7

1	기존제품에 대한 마케팅/판매를 가장 중시	( )	연구개발/기술 선도력을 가장 중시
2	안전한 투자를 선호하는 편	( )	높은 수익을 위한 과감한 투자를 선호하는 편
3	경쟁사들의 전략을 관찰 분석한 후 대응전략	( )	경쟁사들보다 먼저 시장전략을 수립, 추진하는

	을 수립		편
4	외부환경에 점진적으로 대처하는 편	( )	외부환경에 변화에 과감하게 대처하는 편
5	신경영 기법,신기술 등을 업계 최초로 도입하는 것을 꺼리는 편	( )	신경영 기법,신기술 등을 업계 최초로 도입하는 경우가 매우 잦은 편
6	당시 신제품을 출시한 적이 거의 없음	( )	당시 신제품을 출시한 적이 많았음
7	경쟁사와 충돌보다는 공생의 전략을 구사하는 편	( )	경쟁을 불가피한 것으로 보고 적자생존의 전략을 구사하는 편
8	불확실한 시장 상황 하에서는 비용최소화 및 관망하는 자세의 전략을 주로 구사하는 편	( )	불확실한 시장 상황 하에서는 잠재적 기회의 최대한 활용 및 공격적 자세의 전략을 구사하는 편

문 8. 기술개발 프로젝트를 추진할 무렵의 외부적 사업환경을 고려할 때, 귀사는 다음 각 사항들에 대해 왼쪽과 오른쪽 항목들 가운데 어느 쪽에 더 가까운 지 해당 하는 번호를 써 주십시오

(1= 왼쪽 항목에 가장 근접, 4= 양쪽 항목의 중간정도, 7= 오른쪽 항목에 가장 근접)

1---2---3---4---5---6---7

1	마케팅 관행을 바꾸지 않았다	( )	마케팅 관행을 자주 바꾸었다
2	자사 기술과 제품은 개선 필요가 거의 없었다	( )	기술과 제품의 형태를 자주 바꾸어야 했다
3	산업 내 제품/서비스가 진부화 되는 속도가 느렸다	( )	산업 내 제품/서비스가 진부화 되는 속도가 매우 빨랐다.
4	제품에 대한 고객의 요구와 기호 예측이 매우 쉬웠다	( )	제품에 대한 고객의 요구와 기호 예측이 매우 어려웠다
5	경쟁사 행동/전략을 예측하기 매우 쉬웠다	( )	경쟁사 행동/전략을 예측하기 매우 어려웠다
6	산업환경이 비교적 안정되어 회사의 생존과 번영에 문제가 없었다.	( )	산업환경이 매우 적대적이고 작은 전략상의 오류도 기업운영에 치명타가 될 수 있었다.
7	경쟁사들과의 경쟁정도가 치열하지 않았다.	( )	경쟁사들과의 경쟁정도가 매우 치열하였다
8	산업환경을 자사에 유리하게 조정 관리할 수 있었다	( )	자사는 산업환경의 변화에 많은 영향을 받았다

문 9. 기술개발 프로젝트를 추진할 무렵의 귀사가 속해 있는 산업의 성장속도에 관한 질문 입니다. 해당하는 번호를 써 주십시오.

전혀 그렇지 않다.	보통	매우 그렇다
1------ 2------- 3------ 4------- 5------ 6------ 7		

	측정항목	해당번호
1	소비자의 요구가 빠르게 증가하고 있었다	( )
2	자사 상품에 대한 소비자요구는 그 변화가 매우 심하였다	( )
3	자사 상품과 유사한 부류의 상품들이 빠르게 증가하고 있었다	( )
4	자사가 속한 산업은 매우 빠르게 성장하고 있었다	( )
5	자사가 속한 산업에는 아직 미 개척분야가 많았다	( )
6	자사가 속한 산업에는 아직 투자와 마케팅의 기회가 풍부하였다	( )

문 10.기술개발 프로젝트를 추진할 무렵의 전략적 기술제휴에 관한 일반적 인식은 어느 정도였습니까?

질문사항에 관하여 그 해당하는 번호를 써 주십시오

전혀 그렇지 않다.	보통	매우 그렇다

1 ------ 2 ------- 3 ------ 4 ------- 5 ------ 6------ 7

	측정항목	해당번호
1	기술제휴 (협력)는 기업의 기술 혁신이나 성공에 반드시 필요한 경영전략으로 간주되고 있었다	( )
2	동종산업의 타 기업과 비교했을 때, 또는 경쟁사의 타 기업과의 기술제휴를 발표 시, 위기감을 느꼈다	( )
3	기술제휴(협력)는 정보통신관련 중소기업 사이에서 이미 일상적인 기업전략의 하나로 자리잡았다	( )
4	기술제휴(협력)가 기술개발 및 혁신이 아닌, 다른 목적으로 이루어지는 일이 많이 일어나고 있었다	( )
5	우리는 기술제휴 (협력)가 기술개발 및 혁신에 많은 도움을 준다고 믿고 있으며, 가능하다면 타 기업(기관)과 많은 제휴관계를 맺고 싶었다	( )

문 11. 기술개발 프로젝트를 추진할 무렵의 정부차원의 기술협력 지원정책과 노력의 수준은 어느 정도 였습니까?

해당하는 번호를 써 주십시오

매우 미흡.	보통	매우 그렇다
1 ------ 2 ------- 3 ------ 4 ------- 5 ------ 6------ 7		

	측정항목	해당번호
1	기술협력 촉진을 위한 세제 감면	( )
2	기술협력촉진을 위한 저리융자 및 그 밖의 금융상의 지원이나 연구 기금마련	( )
3	기술지원을 위한 산,학,연결 인프라 구축 및 정보 교환 network 망 강화	( )
4	전담부서를 통한 국내외 기술중개, 잠재 협력 파트너 탐색 및 알선, 기술정보관리/평가에 관련된 정보제공	( )
5	독점 금지법 완화 및 지적재산 보호법강화	( )
6	기술협력 시 필요한 기술인력, 교육 및 설비지원	( )
7	기타.( )	( )

*주: 기타는 자세하게 기술하여 주십시오

문 12. 프로젝트에 투자한 자산(설비, 기계, 기술투자, 인력, 건물 등)은 어떤 특성을 가졌습니까? 해당하는 번호를 써 주십시오

전혀 그렇지 않다	보통	매우 그렇다
1 ------ 2 ------- 3 ------ 4 ------- 5 ------ 6------ 7		

	측정항목	해당번호
1	프로젝트 추진 시 많은 직원인력을 투입	( )
2	프로젝트를 추진 시 높은 수준의 노하우나 전문적지식을 투입	( )
3	프로젝트를 추진 시 많은 기계설비 및 장비를 투입	( )
4	프로젝트를 추진하는 데 많은 자금이 소요	( )
5	프로젝트의 효과적 마케팅에 심혈을 기울임	( )
6	프로젝트는 우리회사의 핵심역량에 큰 부분을 차지	( )
7	프로젝트에 투입된 인력, 기술, 장비 등을 다른 프로젝트에 재 투입하기가 쉽지않음	( )

8	제휴관계에 투자한 자산을 그 외에 다른 목적으로 용도변경 할 경우 그 가치가 크게 떨어짐	(　)
9	제휴와 관련하여 일하는 동안 습득한 기술, 노하우, 역량 등은 다른 사업에서 별로 쓸모가 없었음	(　)
10	프로젝트로 개발된 상품/기술은 매우 복잡하고 정교	(　)

문 13. 다음은 프로젝트의 기술적 측면에 관한 내용 입니다. 프로젝트를 통해 개발 또는 개선하고자 하였던 기술(상품, 서비스, 공정 등)적 특성을 고려하여, 해당하는 번호를 써 주십시오

전혀 그렇지 않다			보통			매우 그렇다
1	2	3	4	5	6	7

	측정항목	해당번호
1	개발될 기술(상품)이 우리의 시장목표를 충분히 달성 시킬 것이라고 확신하였다	(　)
2	개발될 기술(상품)이 우리의 기술적 기대치를 충분히 만족 시킬 것이라고 확신하였다	(　)
3	개발될 기술(상품)이 잠재 소비자나 고객들의 요구를 충분히 만족 시킬 것이라고 확신하였다	(　)
4	개발될 기술(상품)이 의도하고 디자인한대로 충분히 기술적성공을 이룰 것이라고 확신하였다	(　)
5	우리는 개발될 기술(상품)이 충분히 상업적 성공을 이룰 것이라고 확신하였다	(　)

문 14. 프로젝트 추진 시 예상했던 기술개발 및 생산비용은 어느 정도 수준이었습니까? 해당하는 번호를 써 주십시오　(　)

매우 낮음			보통			매우 높음
1	2	3	4	5	6	7

문 15. 프로젝트를 통해 개발하고자 했던 기술(상품)의 성격은 어떠합니까? 해당하는 번호를 써 주십시오
(　)

① 완전히 새로운 기술(상품)이다	② 비교적 새 기술(상품)이다
③ 비슷한 기술(상품) 출시가 증가추세에 있다	④ 이미 비슷한 기술(상품)이 출시되었다
⑤ 비슷한 기술(상품)이 이미 신기술에 의해 대체되고 있다	

Part 3. 프로젝트 파트너에 관한 사항입니다

독자적방식이 아닌 기술제휴(협력)방식으로 전자, 정보통신관련 핵심기술 개발 프로젝트 수행 경우, 그 동기와 파트너의 특성에 관한 질문입니다. 프로젝트 수행당시 상황을 고려하셔서 답해 주십시오. 독자적 방식으로 프로젝트를 진행하셨다면, Part 4 로 넘어가 주시기 바랍니다.

문 1. 어떤 형태의 기술제휴 방식을 선택하셨습니까? 해당하는 번호 및 구체적 제휴방식을 기입하여 주십시오. (　)

1) 상호지분참여나 교환을 통한 제휴방식　　2) 지분참여나 교환 없이 공동협력을 통한 제휴

문 2. 파트너회사의 이름과 주사업 분야에 대해 간단히 기술하여 주십시오.

1. 파트너사의 이름		2. 파트너사의 국적	
3. 파트너사의 주 사업분야			

문 3. 연간 매출액과 직원 수 측면에서 귀사와 비교해 볼 때 (파트너가 기업인 경우), 파트너의 상대적 규모는? 해당하는 번호를 써 주십시오 ( )

1) 훨씬 더 작다 2) 약간 더 작다 3) 비슷하다 4) 약간 더 크다 5) 훨씬 더 크다

문 4. 사업상 관계로 볼 때, 파트너는 어디에 해당됩니까? ( )

1)공급업체 2) 고객업체 3) 경쟁업체 4) 직접관련 없는 이업종 5) 공공/정부산하 연구기관
6) 대학부설 연구소 7) 기타:

문 5. 파트너와의 기술협력의 추진동기는 무엇이었습니까? 각 동기의 중요도에 따라 해당하는 번호를 써 주십시오 ( )

(보기)

1: 전혀 중요치 않음	2: 그다지 중요치 않음	3: 보통	4: 다소 중요함	5: 매우 중요함

협력의 동기	해당번호	협력의 동기	해당번호
1.보완적 과학지식이나 기술원천에 접근		2. .거래비용 절감	
3.연구개발의 불확실성 및 개발비용 절감		4.국제화의 부응과 해외시장개척	
5. 네트웍형성통한 시장지배력 강화/ 시너지 효과		6.기업활동 범위와 규모의 확대	
7. 고 위험,고수익 분야에 대한 투자기회 모색		8.시장선점통한 우위적 지위확보	
9.선진기술에 대한 학습, 전수 및 내재화		10.정부기술개발자금 확보	
11.정보, 지식의 공유 및 기술이용범위 확대			
12.기타.(구체적 기술:)			

문 6. 귀사는 이 파트너와 이번 공동 project 건 이전에 다른 건으로도 장단기 상호 협력관계를 가졌던 적이 있습니까? ( )

(☞진행 중 이거나 완료되었던 다양한 형태의 전략적 제휴 (기술제휴, 조달제휴, 생산판매제휴, OEM, 자본제휴 등)나 사업거래관계 모두 포함)

1) 예 (제휴기간: 년) 2) 아니오

문 7. 제휴당시, 파트너에 대해 귀사는 전반적으로 어떠한 평가를 내렸습니까? 해당하는 번호를 써 주십시오

전혀 그렇지 않다	보통	매우 그렇다
1 ------ 2 ------- 3 ------ 4 ------- 5 ------ 6------ 7		

	측정항목	해당번호
1	어떻게 든 우리의 입장을 들어주려고 노력할 것이다	( )
2	이 제휴사업의 성과를 위해 합리적인 의사결정을 할 것이다	( )
3	재무상태, 금융기관과의 관계 및 거래 면에서 효율적인 조직이다	( )
4	자신들의 중요한 이익을 위해 속임수를 쓸 것이다	( )
5	약속을 잘 지킬 것이다	( )

6	어려움에 처하게 될 경우 적극적으로 도와줄 것이다	(　　)
7	부주의나 태만으로 우리를 어려움에 빠뜨리지 않을 것이다	(　　)
8	기업운영, 영업능력, 업무수행에 대한 능력과 자질을 갖추고 있다	(　　)

문 8. 귀사가 보유하고 있던 다양한 지적 재산이나 핵심기술은 파트너 사로부터 어느 정도 보호되고 있습니까? 해당하는 번호를 써 주십시오

전혀 그렇지 않다			보통			매우 그렇다
1 ------	2 -------	3 ------	4 -------	5 ------	6------	7

	측정항목	해당번호
1	우리회사가 보유한 기술이나 지적재산은 국내 특허법에 의해 잘 보호되고 있는 편이었다.	(　　)
2	우리회사가 보유하고 있는 기술이나 지적재산은 무형적, 암묵적 요소가 많은 편이었다	(　　)
3	기술협력 시 우리기술에 대한 파트너사의 부정이용행위가 우려 되었다	(　　)
4	파트너사와 함께 각각 투입하기로 협의한 기술(지식)의 양과 정도를 명시하기 어려운 편이었다	(　　)
5	산업 내에서 기술 유출 및 특허권 침해로 인해 기업간 분쟁이 잦은 편이었다	(　　)

문 9. 파트너와의 기술 제휴(협력)의 범위는 어느 정도 였습니까? (　)

1) 디자인, 유통 등을 포함한 포괄적 기술제휴　　2) 신기술 공동개발에 국한된 기술제휴

문 10. 기술제휴를 통해 공동 개발하기로 한 기술(상품)의 범위는 어느 정도 였습니까? (　　)

1) 한두 종류의 기술(상품)을 개발　　2) 세 가지 이상의 다양한 종류의 기술(상품)을 개발

문 11. 귀사와 파트너사와의 핵심기술 개발능력을 비교 하였을 때, 그 차이는 어느 정도 였습니까? 자사를 기준으로 해당하는 번호를 써 주십시오

훨씬 취약			보통			훨씬 우위
1 ------	2 -------	3 ------	4 -------	5 ------	6------	7

측정항목	해당번호		해당번호
Q1　핵심기술개발	(　　)	Q2　관련기술의 개량	(　　)
Q3　연구개발인력 보유	(　　)	Q4　연구설비와 조직	(　　)
Q5　기술정보 수집 분석	(　　)	Q6　도입 기술 소화개량	(　　)
Q7　기술고문 활용	(　　)		

Part 4: 기술협력 활동에 관한 사항입니다.

문 1. 귀사의 핵심기술(상품)의 발전과정을 아래보기 같이 정의 했을 때, 귀사는 현재 어느 시점에 와 있습니까? 해당하는 번호를 써 주십시오　(　　)

(보기)

① 도입기	② 성장기	③ 성숙기	④ 쇠퇴기

각 시기의 특성
도입기: 개발된 핵심기술(상품)이 아직 잠재 수요자나 시장에 잘 알려지지 않았지만 성장가능성이 매우 높은 시기 성장기: 핵심기술(상품)의 수요가 빠르게 증가하고 매년 10% 이상의 시장성장 성숙기: 핵심기술(상품)의 수요와 시장의 증가가 완만해지며, 시장인지도가 최고조의 시기 쇠퇴기: 핵심기술(상품)에 대해 수요와 시장이 감소하기 시작하며, 대체상품(기술)이 등장. 신상품 개발 시급

문 2. 창사이래 귀사가 수행하였던 기술(제품)개발 총건수와 개발방식을 기입하여 주십시오.

기술(제품)개발 총 건수				
개발 방식	1.외국기술(제품)모방	(　　　) 건	2. 외국기술(제품) 개선	(　　　)건
	3.자사기술(제품)개선	(　　　)건	4. 독자적 개발	(　　　) 건
	5. 기타			(　　　) 건

문 3. 창사이래 귀사가 수행하였던 **공식적인 기술협력**의 빈도 (또는 대략적 추정치)를 기록해 주십시오.

지분투자	1.외국기업과 합작법인	(　　　) 건
	2.국내기업과 합작법인	(　　　) 건
	3.지분 일부인수/참여/매각	(　　　) 건
	4.기타(구체적기술:　　　)	(　　　) 건
비지분투자	5.국내기업으로부터 라이센스	(　　　) 건
	6.외국기업으로부터 라이센스	(　　　) 건
	7.국내동종기업간 공동개발	(　　　) 건
	8.외국동종기업간 공동개발	(　　　) 건
	9.국내동종기업간 개발위탁	(　　　) 건
	10 외국동종기업간 개발위탁	(　　　) 건
	11.국내고객기업과 공동개발	(　　　) 건
	12.외국고객기업과 공동개발	(　　　) 건
	13.연구소와 공동개발	(　　　) 건
	14.연구소에 개발위탁	(　　　) 건
	15.연구소기술이전사업참여	(　　　) 건
	16.대학과 공동개발	(　　　) 건
	17.대학에 개발위탁	(　　　) 건
	18.기타(구체적 기술:　　　) 건	

문 4. 창사이래 귀사가 수행하신 **비공식적 기술협력**의 빈도 (또는 대략적 추정치)를 고려, 해당하는 번호를 써 주십시오

(보기)

1: 거의 없음	2: 2 회-5 회 정도	3: 5 회-10 회 정도	4: 10 회-20 회	5: 20 회 이상

1. 공공연구소/ 유관기관의 기술정보제공	(　　　)
2. 공공연구소/ 유관기관의 시험기자재 공동활용	(　　　)
3. 공공연구소/ 유관기관의 기술개발인력지원	(　　　)
4. 공공연구소/ 유관기관의 품질인증지원	(　　　)

5. 공공연구소/ 유관기관의 기술인력 장/단기 교육	( )
6. 국내장비업체로부터의 기술정보제공	( )
7. 해외장비공급업체로부터의 정보수집	( )
8. 고객기업과의 정기/비정기적 기술정보교환	( )
9. 국내동종업체로부터의 정보수집 및 교환	( )
10. 해외동종업체로부터의 정보수집 및 교환	( )
11. 기타.(구체적 기술:)	( )

문 5. 지난 5 년간 외부와의 공식적 비공식적 기술협력을 통해 귀사의 기술개발 능력 및 핵심기술이 향상되었다고 생각하십니까? 동의하시는 정도에 따라 해당하는 번호를 써 주십시오

전혀 그렇지 않다	보통	매우 그렇다
1 ------ 2 ------- 3 ------ 4 ------- 5 ------ 6------ 7		

	측정항목	해당번호
1	기술선택 능력 (개발대상 및 기술협력선 선택능력)이 향상 되었다	( )
2	기술개량 능력 (완제품, 부품설계기술, 공정설계시술)이 향상 되었다	( )
3	기술창출 능력 (핵심기술 설계능력, 혁신적 연구개발능력)이 향상 되었다	( )
4	실용화능력 (제조기술, 설비관리기술)이 향상되었다	( )
5	기술 습득 및 축적능력이 향상 되었다	( )
6	전반적 기술수준이 향상 되었다	( )

응답자	성명		전화번호		연령	
	직장명		직책		최종학력	
	주소					