Technology-Scanning Capability and Market-Scanning Capability as Drivers of Product Innovation Performance

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Changing trends in customer preference, competitors' offerings, new technologies and development techniques may disrupt a firm from its current leading market position and may favor other firms that prioritize innovation. Once a market opportunity is identified (i.e., find an answer to the 'what to do' question), firms need to engage in a series of activities and information processing to determine an appropriate way to monetize that opportunity – that is, firms need to find an answer to the 'how to do' question. Alternately, a firm may first identify a technological opportunity (i.e. find an answer to the 'how to do') and then find a market opportunity (i.e. find an answer to the 'what to do' question) to make use of the technological opportunity. Two scales that measure the capabilities of firms to address the following two questions – 'what to do' and 'how to do' - were reported; these were labelled as market-scanning capability (MktScan) and technology-scanning capability (TechScan); and these two scales were also tested in a broader research model.

In turbulent environments, marketing and R&D become more challenging, since they face an uncertain future. Firms need to learn systemic scanning and decoding of apparently random changes in their business environment and imagine a pattern that makes sense. One cannot plan for uncertainty. A better strategy is to be prepared for it. One way to prepare is to develop the capabilities that would help the firm to become more adaptive. Drucker (1992) also argued that instead of planning for the long term that is uncertain, firms needed to become adaptive to tackle uncertainty. The ability of a firm to adapt to the changes depends on its ability to sense the nature of the changes in its business environment and respond to

those. Sense-and-respond framework (Haeckel 1999; Haeckel 2000; Day and Schoemaker 2006) was proposed to emphasize the identification of weak signals (Ansoff 1975) to tackle increased uncertainty in business environment. In current days, effectiveness of firm's activities often depends on the richness of its sources of information and its capability to process the collected information to identify the patterns of change happening in its business environments. Information processing may happen in two dimensions: in market dimension and in technology dimension. Firms' capabilities for information collecting and processing in these two dimensions were measured using two firm-level constructs. These are market-scanning capability and technology-scanning capability.

Resource-based theory helped to understand how firms use their tangible and intangible resources to compete in the market. Specific problem-solving aspects of the processes, activities, and cultural norms enable firms to make decisions about engaging the available resources and capabilities in ways that maximize customer value, by realizing the identified opportunities into product and service offerings. This research identified the characteristic strength of this problem-solving approach of firms – collecting information both internally and externally about possible market opportunities and technological options, organization-wide processing of that information, and taking actions to respond using insights gained – as two latent constructs called 'market-scanning capability' and 'technology-scanning capability'.

The concepts of 'market-scanning capability' and 'technology-scanning capability' were first defined and then, scales were developed to enable researchers and managers to measure these firm-level constructs. Next, the predictive roles of these capabilities on firm performance were examined. Empirical analysis for scale development and validation of the research model were performed with data collected through a web-based survey of Canadian manufacturing firms.

Firm performance was captured in two stages – first, by product innovation performance, and second, by overall firm performance. Product innovation performance was used as an intermediate performance measure to examine the direct influence on it of market-scanning capability and technology-scanning capability, and then, to relate product innovation performance to final business outcome measured using 'overall firm performance' scale. The study validated the notion of resource-based theory by supporting the belief that higher levels of market-scanning capability and technology-scanning capability would lead to improved product innovation performance. The role of environmental turbulence was also examined for its possible moderating effect. Two measures of environmental turbulence, namely, technology and market turbulence were used to test the moderation effect. The technology turbulence construct was found to have a moderating effect on the relationship between technology-scanning capability and product innovation performance, indicating that firms needed to focus more attention on the changes in the technology landscape when turbulence in the technological field was perceived to be higher, in order to keep the same level of product innovation performance.

Insight gained from the study contributed to a knowledge-base that might be useful to both practitioners and researchers. The combination of TechScan and MktScan scales could be used as a benchmark tool by managers to assess firms' readiness to take advantage of the opportunities that existed. On the theoretical side, the study contributed to the understanding by showing that both market-scanning capability and technology-scanning capability had direct and indirect influences on firm performance. Also, it was found that the indirect influence of a certain scanning capability became important when firms were pre-disposed to emphasize the other scanning capability.

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Dedication

To my late father, Abul Hashim - a true teacher, who inspires me to serve.

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Chapter 1
Introduction

1.1 General Review

Firms in today's dynamic surroundings need to be extra vigilant to take advantage of the opportunities arising in their business environment and to avoid potential threats. Traditionally, firms have engaged in the practice of environmental scanning (Jain 1984; Smeltzer et al. 1988; Ahituv et al. 1998; Beal 2000; Choo 2001) to inform their decision making. Over time, firms are changing the way they scan their business environment and are increasingly engaging in targeted information seeking (Daft et al. 1988; Dedijer 1999; Raymond et al. 2001; Raymond 2003). Haeckel (1999) proposed that enterprises operating in dynamic environments have to be adaptive and suggested that the success of these firms can be explained by a sense-and-respond framework. In a paper on the design and nature of post-industrial organizations in the Information Age, Huber (1984, p. 928) explained that in order to avoid failure, firms need to emphasize decision making, innovation, and information acquisition and distribution. Taking a holistic view, he identified that firms need to focus on 'post-industrial technologies, structures and processes that would enable them to successfully engage the post-industrial environment and to become viable post-industrial organizations.'

Compared with Industrial Age firms that became successful by making products efficiently and selling them to a large number of consumers, Information Age firms need to follow a different model. Industrial Age firms achieved their success by correctly forecasting the customer demand, by making strategy based on that forecasted future and then, by efficiently executing a plan to achieve edge over their competitions. Information Age firms act as a pool of modular capabilities which are dynamically combined and recombined 'to anticipate' or 'in response to' the changing needs of individual customers where customers themselves are unreliable predictors of their future needs (Haeckel 2000). In such a case, adaptiveness becomes more important than efficiency because it does not matter how good the firms make the products and create the services if the demand for those products and services disappears. Also, when the business environment is dynamic, change does not happen only on the demand side, but may also happen on the supply side. In other words, technologies and techniques that are being used to make products and services are also changing rapidly. If competitors get hold of the newly emerging technologies and use them in their production processes, they may be able to offer substantially improved products and develop them more efficiently. In such cases, even if the focal firm knows about the changing customer needs, it cannot always compete with those firms that have access to better and improved technologies. Hence, firms in the Information Age need capabilities that enable them to know the changing patterns both in customer preferences and in technologies for products and processes.

The sense-and-respond framework emphasizes firms' need to understand the changes in its business environment and provides a specific guideline regarding how to remain viable within the evolving environment. Firms using this framework invest in early detection of 'weak signals' (Ansoff 1975) to broaden their 'peripheral vision' (Haeckel 2004). A sense-and-respond mindset helps firms to identify weak signals what may first appear to be random noises and 'imagine' these signals into a sense-making pattern in order to take decisions that enable firms to respond to these changes that are happening in their business environment.

These weak signals may be related to changes either in the market domain or technology domain. If a signal is picked up in the market domain, it may represent a new customer need or a new type of offering from a competitor. The management in the focal firm would respond to that by looking for tangible ways to fulfill the new customer need or to come up with a new offering that competes with offering(s) from competitor(s). These tangible ways may involve using the technological know-how that already exists within the firm and the knowledge would be exploited to implement the current business goals. However, if the knowledge needed doesn't exist within firms' current knowledge-base, firms will usually scan the environment to acquire new information in the technology dimension (i.e. new technical knowledge will be explored) that will be necessary to implement the change.

Conversely, a weak signal could be picked up in the technology domain and it may represent a new knowledge that could affect either product development or process development. The management in the focal firm would respond to that weak signal by looking for relevant information in the market domain that would support or negate the use of technology under consideration.

Generally, a firm is expected to initially sense these weak signals in both technology domain and market domain (as in 'push-pull' theory, e.g., Zmud 1984). However, depending on the culture of firms and influenced by their unique industry context, some firms may be inclined to sense more signals in technology domain than in market domain, while some other firms will sense more signals in market domain than in technology domain. In other cases, where does this sense-and-respond cycle initiate could be a random selection. However, this selection of sequence will more likely be influenced by the firms' overall culture of 'technology push' or 'demand pull' thinking (Langrish et al. 1912; Myers and Marquis 1969; Gibbons and Johnston 1974; Rothwell et al. 1974; Mowery and Rosenberg 1979; van den Ende and Dolfsma 2005). Irrespective of the approaches, firms need to have well-developed scanning processes in place to access information about the business environment in both market and technology domains.

The increasing popularity of open innovation practices makes the need for the 'peripheral vision' even more important, both for strategic and operational reasons. Open innovation practices (e.g., as characterized by Chesbrough 2003; Kirschbaum 2005; Lichtenthaler 2008) enable firms to capture advantages inherent in real options (Amram and Kulatilaka 1999) by providing early access to embryonic technologies for relatively lower cost, by delaying the internalization of the innovation process, and by providing the choice of early exit if technology development does not progress as expected (Vanhaverbeke et al. 2008). To realize these advantages effectively, firms need to sense the changes occurring in both technology and market domains. For example, depth of knowledge about developments in the technology field will help firms to engage external players of technologies that might become relevant in future. At the same time, a good understanding of changing market trends helps firms to select one or more embryonic technologies for internalization when those become relatively mature. If knowledge from either technology domain or market domain indicates that a particular development would not fit well with the planned product or service portfolio, the firm may choose to avoid, or exit early, to sidestep further development costs.

Several authors claimed, the capabilities of firms to understand the direction of changes in market and technology domains are preconditions to success when operating in a dynamic environment (e.g. Capon and Glazer 1987; Bond and Houston 2003). These capabilities assist firms reduce uncertainty from two important sources: (1) uncertainty about the amount and type of demand for the firms' products and services, and (2) uncertainty about developing technologies. These two sources are important since firms have to sense the nature of their customers' changing needs and wants (i.e. 'what' needs to be done), and then find out what technologies can be used effectively to create the desired products or services (i.e. 'how' it will be done). In addition, and more importantly, firms need to use both of these capabilities simultaneously given the dynamic nature of the business environment. Thus, information processing capabilities in technology and market domains help firms to imagine a clearer picture of future at the very early stages of new product or service development efforts.

Market-oriented firms perform better than their less market-oriented counterparts (Narver and Slater 1990; Ruekert 1992; Deshpande et al. 1993; Jaworski and Kohli 1993; Slater and Narver 1994; Atuahene-Gima 1995; Pelham and Wilson 1996; Pitt et al. 1996). Firms with a high degree of market-scanning activities have improved capability to process information that relates to the changes in the customer choice and this capability enables firms to significantly reduce the demand uncertainty for their products and services; i.e. these firms have a better idea about 'what needs to be done'. While many scholars agree that market orientation is an important and necessary characteristic of better-performing firms, they also indicate that this capability is not sufficient to enable firms for continuous innovation and thereby, to achieve competitive advantage (Day and Nedungadi 1994; Slater and Narver 1995; Baker and Sinkula 2002). This is more applicable to manufacturing firms than to service firms (Cano et al. 2004). Firms explore ideas for new products and services to meet identified and unexpressed customer needs (e.g., 'lead users' in von Hippel, 1988). Firms then find ways to develop these new and improved products and services that increase the likelihood of business success. In order to find an appropriate way to develop these products and services, firms gather and process information about available technological options. Firms use market information to guide the purposeful search for technologies to address customers' need and this practice can enable firms to achieve better performance. This way is akin to the pull model of new product development (Langrish et al. 1912; Myers and Marquis 1969; Gibbons and Johnston 1974; Rothwell et al. 1974; Mowery and Rosenberg 1979; van den Ende and Dolfsma 2005).

Technology-oriented firms place emphasis on using technological knowledge to solve their customers' problems (Gatignon and Xuereb 1997). These firms are proactive in acquiring new technologies and use them while developing new products (Cooper 1984; Cooper 1994). Atuahene-Gima and Evangelista (2000) asserted that technology-oriented firms are more likely to promote technology in their new products at the expense of customer needs; these firms are pre-disposed to push a certain technology into the market. Such firms have a pro-technology culture, according to Workman (1993; 1998), and these firms are likely to depend more on R&D insights than marketing insights. Firms with high degree of technology orientation have improved capability to process technical information and they are better in reducing uncertainty in developing technologies; i.e. these firms have a better idea about how things should be done. Hence, when firms effectively use their technology knowledge to find applications in products and services that are popular, firms achieve higher performance. This model is akin to push model of new product development (Langrish et al. 1912; Myers and Marquis 1969; Gibbons and Johnston 1974; Rothwell et al. 1974; Mowery and Rosenberg 1979; van den Ende and Dolfsma 2005).

A high level of scanning capability in both market and technology domains may be more necessary for firms in dynamic industries; since firms often experience high intensity change in both of these domains (Cetron and Davies 2001; Day and Schoemaker 2004) and uncertainties are often very high in both dimensions. These fast changing trends in development techniques and technology, customer preference and other environmental factors can deprive a firm of its current leading market position, allowing other firms, which place priority on innovation, to take the lead. One such example is Wang Computer, which "led the word processing industry in the early 1980s before Apple and IBM introduced PCs with word processing software. …Wang could not see how PCs offered customer value. As a result, Wang's sales dropped and it went bankrupt" (Cohan and Unger 2006, p. 11). To avoid such outcomes, firms need to search for and use the latest information to apply management practices effectively when innovating new products and services, a tactic that would eventually enable firms to achieve sustainable competitive advantage (Han et al. 1998). The current study adds to the understanding of this topic by explaining how information processing capabilities of a firm may help achieve competitive advantage – firms do so by developing market-scanning capability and technology-scanning capability. Market-scanning capability enables firms to effectively recognize customers' changing needs and to decide on how to satisfy those needs either by implementing new products and services or by making changes to current products and services. Technology-scanning capability helps managers to make informed decisions on the use of technological options to implement those new products and services or to make changes to current products and services. Hence, the definitions that are used in this study for the two capabilities are as follows:

> ***Market-Scanning Capability (MktScan)*** makes firms aware of market opportunities – both explicit and tacit – within industries in which the firms

operate. Market-scanning capability also facilitates finding new opportunities beyond the market segments currently on focus.

Technology-Scanning Capability (TechScan) makes firms aware of technological opportunities that can be acquired or licensed from outside the firm, in addition to using the knowledge to develop the technology internally. Technology-scanning capability facilitates the finding of technological solution to an identified or anticipated customer problem.

The Strategic Management literature suggests that a firm's performance depends on innovation (Alderson 1965; Buffa 1984; Foxall 1984; Butler 1988; Hamel and Prahlad 1989; Miller 1989; Dickson 1992; Wolfe 1994; Friar 1995; Rogers 1995; Gatignon and Xuereb 1997; Johannessen et al. 1997; Kandampully and Duddy 1999; Hoffman 2000). Lengnick-Hall (1992) examined the link between innovation and competitive advantage and found that innovation adds to a firm's sustainable competitive advantage through:

1. inimitability (Porter 1985; Clark 1987)
2. complementary innovations with respect to market realities (Deming 1982; Porter 1985)
3. well-timed innovations for the industries within which the firm operates (Kanter 1983; Betz 1987)
4. innovations that rely on capabilities and technologies that are readily accessible to the firm (Ansoff and McDonnell 1988; Miller 1992).

Utterback and Abernathy (1975) found that performance maximizing strategies emphasize advances in technology and product as a key to competitive advantage. They also argued that cost-minimizing strategies emphasize process technology innovation as a way to decrease the total cost of production. Similarly, Miles and Cameron (1982) stated that product innovation provides the focus of an offensive business strategy. Other publications also identify firms' ability to innovate as a critical factor to achieve business performance (e.g., Im and Workman 2004; Zaheer and Bell 2005; Alegre and Chiva 2008; Gomes and Kruglianskas 2009; Hernandez-Espallardo and Delgado-Ballester 2009). A general conclusion of this literature is that innovation forms part of the distinctiveness that helps firms establish their competitive advantage and enable firms to gain control over product performance and product price.

Competitive advantage is attained by a firm in the context of effective use of firm resources to engage the opportunities that arise in the business environment in which the firm operates. However, in a dynamic business environment, the existing opportunities may disappear and the firm's static resources may no longer be enough to sustain the competitive advantage it once had. Hence, the very concept of sustainable competitive advantage within resource-based view of the firm is problematic when the business environment is changing. To avoid this problem in the conceptualization, the later authors have extended the resource-based view and used a broader definition of resources that not only included assets but also capabilities. In this context, a valuable capability that a firm needs to sustain its competitive advantage is to sense the changing nature of its business environment (e.g., market-scanning capability). However, this is only a necessary condition for firms to sustain their competitive advantage since the firm may find itself in a situation where it knows what kind of changes are expected in its business environment, yet the firm may not have the resources or know-how to monetize the expected change in its business environment. In such a situation, the firm would need another capability (e.g., technology-scanning capability) to find out the techniques and technologies that it could use to create or change its products and services and thereby monetize the expected changes. Together these two capabilities to perform market-scanning and technology-scanning, does the firm recapture its ability to maintain its sustainable competitive advantage even when it faces a dynamic business environment.

Overall, the research first developed a firm-level construct to measure technology information processing capability called 'technology-scanning capability' (TechScan). Additionally, existing market information processing related constructs were used to define another firm-level construct to measure market information processing capability namely 'market-scanning capability' (MktScan). The influence of these two constructs on innovation performance was tested in a sample of Canadian manufacturing firms. The following chapters review the literature on capability development and develop the research model; describe the method and findings; and finally, discuss the implications for future research and managerial practice.

1.2 Objective and Research Questions

A major objective of this study was to develop measurement scales for technology-scanning capability (TechScan) and market-scanning capability (MktScan) constructs. To develop TechScan scale, research in technology management, product development and innovation were reviewed to identify potential items for the scale. Further opinion survey of experts and practitioners and exploratory factor analysis using data from a national web-based survey was performed to refine the scale items. To develop MktScan scale, existing scales on related constructs were used to identify the potential items and those items were used to collect data through the national web-based survey. These items were further refined through exploratory factor analysis. Well-developed capabilities for technology-scanning and market-scanning help managers make informed decisions about existing opportunities and threats arising in both technology and market domains. These capabilities in turn increase both innovation performance and business performance of firms. The scales that have been developed here will enable researchers to measure technology-scanning capability and market-scanning capability at firm-level.

Once the measurement scales for technology-scanning capability and market-scanning capability constructs were developed, those were used in the context of overall research model. The research questions investigated in this study were:

1. How should firms proceed to gain knowledge about 'what are the customers' needs' and 'how to satisfy those needs'?
2. Whether the market-pull and technology-push characteristics of the firms have an influence on how market-scanning capability and technology-scanning capability play their role to achieve performance?
3. How do firms ensure that their performance is sustainable over an extended period?
4. How does turbulence in the business environment in which firms operate influence other relationships?

1.3 Potential Theoretical Contribution

The contribution of this study can be observed at several levels. First, the study helped clarify two important firm-level capabilities of technology-scanning and market-scanning by developing scales to measure the strength of these capabilities in firms. Second, using the resource-based view of firms as a theoretical anchor, the study examined how these two intangible resources under consideration help further the understanding of the theory. These two intangible resources are: market-scanning capability that helps firms sense the changing trends in customers' preferences, and technology-scanning capability that helps managers make informed decisions on the use of technological options when deciding how to implement a new product or service to satisfy customers' changed preferences. These two capabilities of firms were measured and tested for their role in achieving firm-level product innovation performance. Yet another contribution came from the way the study used the performance measures to establish the sustainability of competitive advantage. The intangible internal resources of firms (e.g., market-scanning capability, technology-scanning capability) cannot explain all the variations in the overall performance of a firm, because performance is also dependent on many other external factors (e.g. state of the economy, competitive pressure, cyclical trend, etc). Hence, the study used an intermediate performance measure of product innovation performance that is expected to more closely reflect the variation in internal intangible resources of the firms. Use of this intermediate performance measure had two advantages: First, it prevented the use of the overall firm performance to directly test the influence of intangible resources – hence matched the reality. Second, since intangible resources are relatively less fungible, their influence is also expected to sustain longer. Hence, measure of product innovation performance was used to capture the sustainability aspect of a firm's performance. This also enabled the use of a cross sectional study – as opposed to using a longitudinal study – and yet capture the sustainability aspect of competitive advantage of firms to some extent.

Lastly, the study not only examined the influence of resources on a firm's performance (which is main premise of resource-based view of firm), it also helped to examine how one resource could help explain the influence of other resources – that is, the study captured the mediation effect between the influences of two intangible resources under consideration.

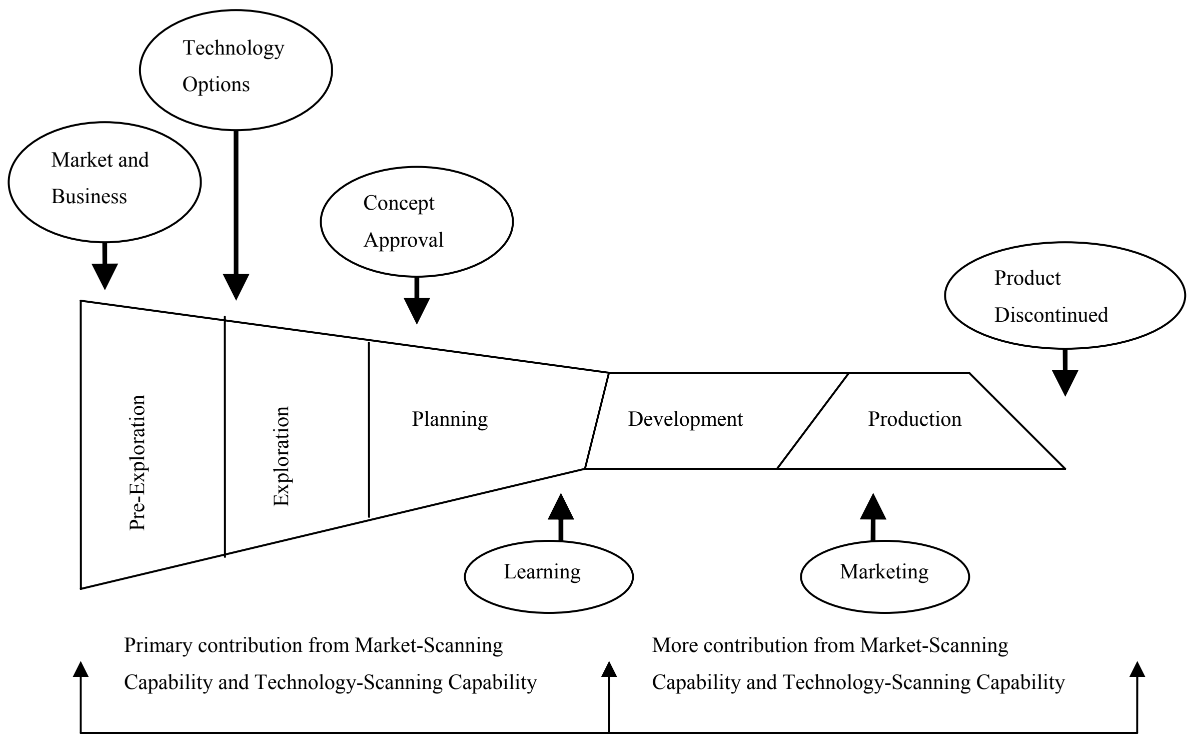
1.4 Relevance of Research for Practitioners

In the development of any marketable product, early decisions are made that eventually influence the probability of achieving long-term competitive advantage or taking advantage of short-term opportunities that arise in an ongoing basis. As shown in Figure 1-1, the primary contribution of technology-scanning capability and market-scanning capability is made in the early stages of the product life-cycle; for example, during exploration and planning; when raw ideas are conceptualized and product strategies are made. However, contributions from scanning continue past these early stages, providing useful information that helps managers make decisions during later stages of the product life cycle; for example, during development, testing, and distribution. Intel, the leading semiconductor chip maker, uses a five-stage product life cycle model (Intel 2005). For any firm following a similar process, the primary contribution of technology-scanning capability and market-scanning capability comes during the pre-exploration, exploration and planning stages. As another example, decisions at Gate-1 and Gate-2 of the Stage-Gate new product development process (Schmidt 2005, p. 338) can benefit from enhanced levels of market-scanning capability and technology-scanning capability. Similarly, the well-known telecommunications manufacturer Motorola Inc. follows the M-Gate process (Motorola 2002, p. 42), with managers making early decisions throughout Gate-15 to Gate-11 as well as at later gates. These early decisions are geared towards gaining long-term competitive advantage and taking advantage of short-term opportunities on a continuing basis. For firms that do not follow any such staged processes, market-scanning capability and technology-scanning capability are equally important as these help firms to identify opportunities early in the development life-cycle. Moreover, with the increasing popularity of open innovation (Chesbrough 2003), stronger capabilities of market-scanning and technology-scanning would indicate readiness of firms to pursue open innovation strategy effectively. In a sense, the combination of market-scanning capability and technology-scanning capability can be thought of as important elements in practitioners' toolbox to manage open innovation.

1.5 Thesis Organization

The dissertation has four additional chapters. Chapter 2 reviews the literature and describes how the resource-based theory of a firm anchors the study and how the theoretical framework is operationalized in the context of the current study. The chapter then presents the overall research model and relevant hypotheses about the relationship between market-scanning capability, technology-scanning capability, product innovation performance and overall firm performance. Chapter 3 describes the research methodology and presents analysis. An important part of the research is to clarify the concepts of market-scanning capability and technology-scanning capability and develop scales to measure these capabilities. This chapter also presents the measurement scales that are used in the study to measure other latent constructs. The chapter then describes how data were collected through a national survey. Chapter 3 also discusses procedural remedies that were undertaken during survey design and administration at the end of the chapter. Chapter 4 presents the results of data analysis. Chapter 5 provides a summary of findings from the current study, describes limitations of the study, identifies the future direction of research, and explores the theoretical and practical implications of the findings and conclusions.

Figure 1-1 Market-Scanning and Technology-Scanning in Product Life Cycle



Chapter 2
Literature Review and Research Model

2.1 Introduction

Sense-and-respond framework provides an organization its business context, helps its leaders to define reason for being, governing principles and high-level structure of the business (Haeckel 2000). While the sense-and-response framework is useful with these business objectives in the conceptual domain, it is, however, not very helpful when it comes to understanding the interactions among various constructs that measure different capabilities to enable sensing and responding in the quantitative domain. The resource-based view of firms (Wernerfelt 1984; Barney 1991; Teece and Pisano 1994; Wernerfelt 1995; Eisenhardt and Martin 2000; Barney et al. 2001) was used as the underlying theoretical framework to explain the interactions among the constructs of the research model. First, the operationalization of the theory in the context of the current study was presented. Then, a consolidated review of the literature was performed to develop an integrated research model capturing the interactions among market-scanning capability, technology-scanning capability, product innovation performance and overall business performance. Four hypotheses relating to the basic research model are presented first. Next, four additional hypotheses are presented to examine the influences of two different types of environmental turbulence on the main casual relationships that are being considered in the basic research model.

2.2 Resource-Based View as Underlying Theoretical Framework

The resource-based view of the firm (Wernerfelt 1984; Barney 1986; Barney 1991; Conner 1991; Peteraf 1993; Barney 2001) was used as an important anchor for the current study. Having its roots in Penrose (1959), this theory looked at resources at the firm level as opposed to product-based analysis at the industry level. The core contribution of the theory was that it helped explain why some firms achieve sustainable competitive advantage. The theory held that some firms achieve sustainability in competitive advantage by differentiating resource endowments that they create (Wernerfelt 1984; Barney 1986; Barney 1991). This theory used a broad definition of resources: "all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm" (Barney 1991, p. 101). These resources were valuable, rare, inimitable, and non-substitutable. In addition, the resources could be viewed as a bundle of tangible and intangible assets, including a firm's management skills, its organizational processes and routines, and the information and knowledge under its control (Barney et al. 2001).

Both market-scanning capability and technology-scanning capability were viewed as two resources that enabled firms to identify the opportunities and threats in the business environment and successful use of these capabilities gave rise to product innovation performance for the firm. In the parlance of resource-based view, when firms successfully create differentiating resource configurations, they could better satisfy their customers' needs, they produced more efficiently, and eventually, they achieved superior performance leading to competitive advantage (Barney 1991; Peteraf 1993). For this study, the underlying assumption was that when firms had increased product innovation performance, they could convert their better-matched products and services into overall business performance, leading them eventually to gain sustainable competitive advantage. It was also acknowledged that product innovation performance was neither automatic nor sufficient; rather it was a necessary condition for sustainability of competitive advantage.

Newbert (2007) reviewed 55 empirical studies based on the resource-based view (RBV), and found 53 percent of them supported the expected results as suggested by RBV. Further, to explain the result, Newbert noted that researchers used three broad categories of independent variables – resources, capabilities and core competences. The level of support varied widely among studies based on the resource categories used as independent variables. When a specific capability was used as the independent variable, 71 percent of the tests were supported; when core competence was used as the independent variable, 67 percent were supported. But when specific resources were used as the independent variable, support level went as low as 37 percent. Although the authors of the original studies argued that these resources, capabilities and core competences are valuable, rare, inimitable, or non-substitutable, the overall outcome indicated that these characteristics were not strong at the same level in different categories.

A further review of the specific instances of these resources, capabilities and core competences revealed the following: The top three resources that were used are human capital, knowledge and experience; the top three capabilities that were used are information technology, technological and human resource; and the top three core competences that were used are architectural, marketing and technological. A resource like human capital or experience is more likely to be imitable, substitutable, and less rare than technological capability or marketing competence of the firm. Indeed, Barney (2001) asserted that a valuable and rare resource could be helpful only when it was inimitable. Inimitability of a resource depended on several factors: (1) the unique historical context in which resource bundles were created, (2) a causally ambiguous relationship between the resources and resulting competitive advantage, and (3) social complexity of the resources (Lippman and Rumelt 1982; Dierickx and Cool 1989; Armstrong and Shimizu 2007). Hence, it seemed plausible that the use of capabilities and competences as independent variables were more appropriate if one wanted to use the resource-based view as a theoretical framework. There was a problem though, in this categorization of the independent variables in RBV studies. Among the top three entries of capabilities and core competences categories, the term 'technological' was present in both categories. It was however not very clear how technological capability was different from technological core competence. The inherent ambiguity in the use of terminology to identify different categories was a problem.

In other theoretical developments, the resource-based view had been extended to account for the nature of the business environment that is increasingly fast-changing. The 'dynamic resource-based view' of the firm (Helfat 2000; Helfat and Peteraf 2003) used the notion of dynamic capabilities (Teece et al. 1997; Eisenhardt and Martin 2000) in explaining how resources and capabilities are continually changed, integrated, and reconfigured to create new resources and capabilities. This view claimed to address the fast-changing nature of business environment better. On a similar thread, Wiggins and Ruefli (2002; 2005), drawing on the works of Schumpeter (1939; 1942) and D'Aveni (1994), explained how hyper-competition diminishes competitive advantage among firms. Due to more changes in the business environment, firms are finding it increasingly difficult to retain for a longer time their strategic advantage over their competitors. Rather, sustained competitive advantage is increasingly becoming dependent on the firms' ability to create over time a series of competitive advantages (Wiggins and Ruefli 2005). In other words, firms operating in hyper-competitive business environments characterized by high 'clock-speed' (Fine 1998) develop capabilities that enabled them to create a series of temporary advantages which, in turn, helped achieve sustained competitive advantage over a duration of time (D'Aveni 1994; Brown and Eisenhardt 1998). This view was complementary to the dynamic resource-based view – if one considered how these temporary advantages were created through the frequent adaptation and reconfiguration of resources. In pursuit of identifying and benefiting from these temporary advantages on a continuous basis, firms develop information collecting and processing capabilities that focus on both market and technological domains.

Following Fahy and Smithee (1999), the label 'resource' was adopted as all-embracing one which could indicate either one of the following three: tangible assets, intangible assets or capabilities. Tangible assets referred to the fixed and current assets of the organization that had a fixed long run capacity (Wernerfelt 1989). Intangible assets included intellectual property such as trademarks and patents as well as brand and company reputation, company networks and databases (Hall 1992; Williams 1992). Capabilities referred to the skills of individuals or groups as well as the organizational routines and interactions through which firm's resources were coordinated (Grant 1991). These capabilities also help firms to reliably and consistently achieve a specific outcome. A capability is 'ensured through a combination of processes, tools, knowledge, skills, and organization that are all focused on meeting the desired result" (Alvarez and Raghavan 2010, p. 2).

2.3 Operationalizing Resource-Based View

The resource-based view of a firm can explain and predict the firm's sustainable competitive advantage, assuming that its resources are valuable, rare, inimitable and non-substitutable. A sustainable competitive advantage is usually reflected in performance-related outcomes (Henderson and Cockburn 1994; Rouse and Daellenbach 1999; Barney and Arikan 2001). Bacharach's (1989) framework was used to operationalize the theory for the current study. The framework provided three different guidelines: for operationalizing independent variables, that is, technology-scanning capability and market-scanning capability; for operationalizing dependent variables, that is, product innovation performance and overall firm performance; and for operationalizing relationships between independent and dependent variables. For operationalizing the independent variables, Newbert (2007) identified three common categories in use: resources, capabilities and core competences. Priem and Butler (2001) stated that there were three levels in the use of independent variables: specific resources, or 'lower-level constructs'; resources, or constructs; and variables that reflected theorized resources. Both capability and the core competence categories of Newbert could be represented by latent constructs that were similar to Priem and Butler's variables that reflected theorized resources. Moreover, this representation of resources had relatively stronger support in reported empirical studies (Newbert 2007). In this study, two latent variables were used to represent two intangible resources reflecting firms' market-scanning capability and technology-scanning capability. This categorization was also supported by Fahy and Smithee (1999) and Grant (1991).

2.3.1 Operationalizing Independent Variables

By definition, the intangible, hard-to-create and hard-to-observe resources are inimitable to some extent. On the one hand, these inimitability of resources likely help the firms to achieve sustainable competitive advantage; on the other hand, the same characteristics of these resources make them inherently difficult to measure (Godfrey and Hill 1995; Zander and Kogut 1995). Often, these intangible resources are the capabilities of firms and are modeled as latent constructs. The apparent difficulty in measuring these capabilities is usually handled by a mix of methods, and researchers had used a combination of qualitative and quantitative techniques to develop scales to measure these latent constructs. Many studies had contributed to the development of the scales to weigh these inherently difficult-to-measure resources and capabilities (Barney 2001; Levitas and Chi 2002). The use of qualitative approaches to develop quantitative tools (e.g., scales) had been suggested as particularly useful in the ‘high-velocity’ environments, as information and prior knowledge quickly becomes obsolete in such environments (Bourgeois and Eisenhardt 1988). In doing so, many researchers used survey methodology to measure the resources that were inherently unobservable and hard to create. A combination of literature search and opinion survey of experts and practitioners were used to develop a scale to measure technology-scanning capability. Market-scanning capability scale was created based on few market orientation scales from extant literature. Factor analysis was then used to further refine the scales. Then, the measures of market-scanning capability and technology-scanning capability were both used to test the resource-based view of the firms in the context of present study.

2.3.2 Operationalizing the Dependent Variable

Studies anchored in the resource-based view face challenges in defining sustainability in terms of duration or degree, hence the attention in this regard in empirical studies are limited (Armstrong and Shimizu 2007). Firms that achieve above-average returns for a certain duration of time could be viewed as achieving a sustained competitive advantage (Barney 1991; Conner 1991; Amit and Schoemaker 1993). It should be noted that firms with imitable resources could also achieve competitive advantage and superior performance for a short period. So, defining outcome variables in a clear way that are sustainable, or ascertaining continued superior performance outcome over a period of time, could contribute to the understanding of inimitability of resources (Dierickx and Cool 1989). Based on the choice about how to deal with sustainability, research design might either be cross-sectional or longitudinal.

There is also the issue of context – the understanding of sustainability depends on time and industry. In some industries, like video gaming, one year may be considered long enough to achieve a performance that is sustainable, whereas in other industries, like materials, one year would not be long enough. In order to capture the 'sustainability' aspect of performance outcomes, longitudinal research design is a straight-forward way to handle the issue. The process is not, however, so easy when it comes to collecting data, specifically so if someone is planning to collect data from primary sources. For those researches using secondary sources of data, longitudinal studies seem more feasible, whereas in case of studies using primary data, longitudinal design would likely not be the optimal option. There were other studies that had used cross-sectional design to capture the sustainability aspect of the outcome variable; in such cases, researchers used qualitative reasoning to establish causality and dynamics, objectives not always easy to accomplish. The latter option was also more appropriate in terms of generalizability across industries and time. Armstrong and Shimizu analyzed 125 empirical studies; they found only four studies (Pettus 2001; McEvily and Chakravarthy 2002; Schilling and Steensma 2002; Wiggins and Ruefli 2002) that paid specific attention to this issue. Of these studies, the first two studies used longitudinal design and other two used cross-sectional research design. For the current study, product innovation performance was used as the outcome or dependent variable that was influenced by both market-scanning capability and technology-scanning capability. It was reasoned that with the higher level of these capabilities, firms attained product innovation performance that, in turn, helped them achieve overall business performance that was sustainable. The inherent advantage of being innovative helped firms maintain their advantage once it was achieved.

There is another challenge in operationalizing the dependent variable for studies that use RBV as their theoretical basis. Many empirical researches on RBV used overall firm performance as the dependent variable (Barney and Arikan 2001). This is problematic in that studies might account for only a selection of resources (i.e. assets and capabilities) that a firm had, while the outcome variable of overall firm performance was the aggregated result of all the resources of the firm (Ray et al. 2004) plus any other external factors that might had been in play at the time. In other words, the influence of resources under consideration might had been masked by the influence of other resources on the same outcome variable at the time (Henderson and Cockburn 1994). Moreover, if firms had multiple business units, the confounding effect could be even more. To mitigate this issue to some extent, the dependent variable was treated in two stages. While the effects of both market-scanning capability and technology-scanning capability on overall firm performance were examined, these capabilities did not directly influence the overall firm performance in the model. The effects of these capabilities on product innovation performance were first tested in an attempt to isolate the dependent variable from a number of other factors that are in play at any given time. After that, secondary effect on overall firm performance was examined via product innovation performance.

2.3.3 Issues Influencing Relationship between Independent and Dependent Variables

The relationships between independent and dependent variables do not depend on themselves only; a number of other factors may also influence their direction and strength. Among others, the turbulence of the business environment and level-of-analysis of the dependent variable was examined by researchers (Kohli and Jaworski 1990; Slater and Narver 1994). The presence of strong environmental turbulence could moderate the relationship between independent variables and dependent variables. In the current study, two measures of environmental turbulence - namely, market turbulence and technological turbulence - were used to test the moderating effect on the relationship between capability and performance variables.

The use of a single industry context to test the RBV has its advantages and disadvantages. The value of a particular resource often depends on the industry (Rouse and Daellenbach 1999). So when researchers focus on a single industry to achieve a deeper understanding of that particular sector, they also limit the generalizability of their findings because of the possible resource value idiosyncrasy (Barney 2001; Priem and Butler 2001). At the broad level, if one wanted to examine the validity of the underlying RBV theory itself, generalizability could still be pursued by aggregating the findings of different single-industry studies (e.g., Jensen 1983). However, if researchers wanted to focus on the specific context of a study and wanted to achieve better generalizability, as well as increase the sample size, they examined RBV in a multi-industry setting (Dess et al. 1990; Hoskisson et al. 1999). In reviewing 125 RBV-based empirical studies, Armstrong and Shimizu (2007) found that 53% of the researchers used multi-industry setting. In the current study, survey participants were recruited from multiple industries to increase both the sample size and generalizability.

2.4 Research Model and Hypotheses

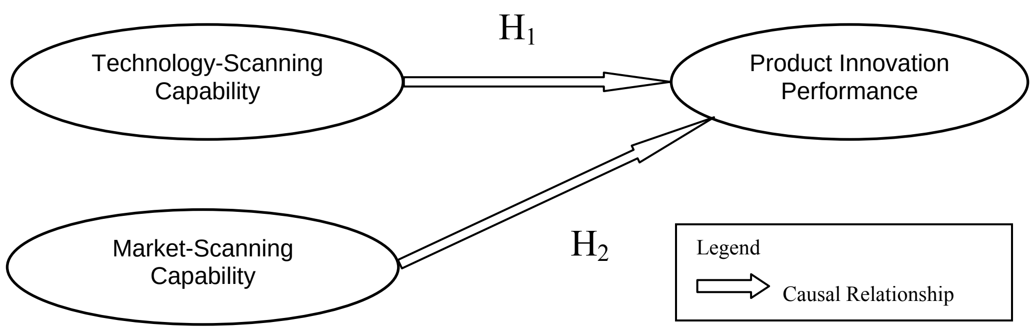
RBV conveys the implication that both market-scanning and technology-scanning capabilities under consideration would positively influence the immediate dependent variable of product innovation performance. These two capabilities enable firms to detect 'weak signals' (Ansoff 1975) that are early indications of future changes either in market or technology domain. Based on these early indications, firms can respond in a timely manner as described by the sense-and-respond framework (Haeckel 1999; Haeckel 2000). These two capabilities of firms are demonstrated in the richness of sources of information and their ability to process the information. Firms identify the signals what may first appear to be random noise to an untrained eye and 'imagine' those signals into a sense-making pattern in order to make decisions. In a sense, firms act as a pool of modular capabilities which are dynamically combined and recombined to sense the changing needs of individual customers where customers often do not have a clear idea about their own future needs (Haeckel 2000). While both market-scanning and technology-scanning capabilities have been reconceptualized for the current study, the related concepts and previous studies involving those helped to hypothesize how these two capabilities might influence firm-level performance measures.

A popular concept that is related to market-scanning capability is firm-level market orientation. The effect of market orientation on firm performance have enjoyed great interest among researchers (Narver and Slater 1990; Ruekert 1992; Deshpande et al. 1993; Jaworski and Kohli 1993; Slater and Narver 1994; Atuahene-Gima 1995; Pelham and Wilson 1996; Pitt et al. 1996). This relationship was not always direct, being often dependent on other factors such as organizational responsiveness (Hult et al. 2005) and types of firms (Cano et al. 2004). For this study, few related scales on market orientation were used to develop the new scale for market-scanning capability. A new scale to measure technology-scanning capability was also developed. Although the current conceptualization of technology-scanning capability is new for this study, other technology-related concepts had been used by researchers (Gatignon and Xuereb 1997; Julien et al. 1999; Carayannisa and Alexander 2002; Julien et al. 2004; Díaz-Díaz et al. 2008) to study similar effect of those on performance of firms. Particularly, in a survey of 1267 Spanish industrial firms, Díaz-Díaz et al. (2008) found a mediated relationship between technological knowledge asset and financial performance. The effects of both market-scanning capability and technology-scanning capability on product innovation performance were examined, and the first two hypotheses were formulated, as shown in Figure 2-1, based on resource-based view of the firm.

H_1: Firms with higher level of technology-scanning capability will have a higher level of product innovation performance.

H_2: Firms with higher level of market-scanning capability will exhibit a higher level of product innovation performance.

Figure 2-1 Research Model (Hypotheses H_1 & H_2)



The sense-and-respond framework (Haeckel 1999) helped to understand how information age firms successfully operated in a fast-changing business environment. This framework however did not provide a clear indication about where firms might source their signals first and where they might get their information then to respond to those weak signals. A firm might first sense a weak signal either in the market domain or in the technology domain. In other words, the sense-and-respond cycle might initiate either in market domain or in technology domain and it might depend on the firm culture, the unique industry context or it could be a random sequence.

Firms that are traditionally driven by market domain knowledge are known as market-pull firms (Langrish et al. 1912; Myers and Marquis 1969; Gibbons and Johnston 1974; Rothwell et al. 1974; Mowery and Rosenberg 1979; van den Ende and Dolfsma 2005). Market-pull firms would be inclined to use their market-scanning capability more often to identify new ideas to fulfill a potential new customer need. These firms might also identify a potential new offering from a competitor through the use of market-scanning capability. Once an opportunity for a new product or service or a threat from a competitor is identified in the market domain, firms would then respond to that by exploring or exploiting technology domain knowledge. This might involve exploiting technological know-how that already exists within the firm or it could involve exploring new information in the technology domain that would be necessary to implement the change. The sequence of sense-and-respond cycle would start in the market domain for firms that are culturally inclined to market-pull characteristics. These firms would exhibit stronger level of market-scanning capability that might translate into product innovation performance mediated by technology-scanning capability. This led to hypothesis H_{3a} as depicted in Figure 2-2.

H_{3a}: In case of firms with market-scanning capability greater than technology-scanning capability, technology-scanning capability will mediate the relationship between market-scanning capability and product innovation performance.

Firms that are traditionally driven by technology domain knowledge are known as technology-push firms (Langrish et al. 1912; Myers and Marquis 1969; Gibbons and

Johnston 1974; Rothwell et al. 1974; Mowery and Rosenberg 1979; van den Ende and Dolfsma 2005). Technology-push firms would be inclined to use their technology-scanning capability more often to identify a new technological opportunity – either in the form of a new technology or in the form of re-using an existing technology. Once a technological opportunity is identified in the technology domain, firms would then respond to that by exploring new knowledge in the market domain or by exploiting their existing market domain knowledge. The sequence of sense-and-respond cycle would start in the technology domain for firms that are culturally inclined to technology-push characteristics. These firms would exhibit stronger level of technology-scanning capability that would translate into product innovation performance mediated by market-scanning capability. This led to hypothesis H_{3b} as depicted in Figure 2-3.

H_{3b}: In case of firms with stronger technology-scanning capability greater than market-scanning capability, market-scanning capability will mediate the relationship between technology-scanning capability and product innovation performance.

Figure 2-2 Research Model (Hypothesis H_{3a})

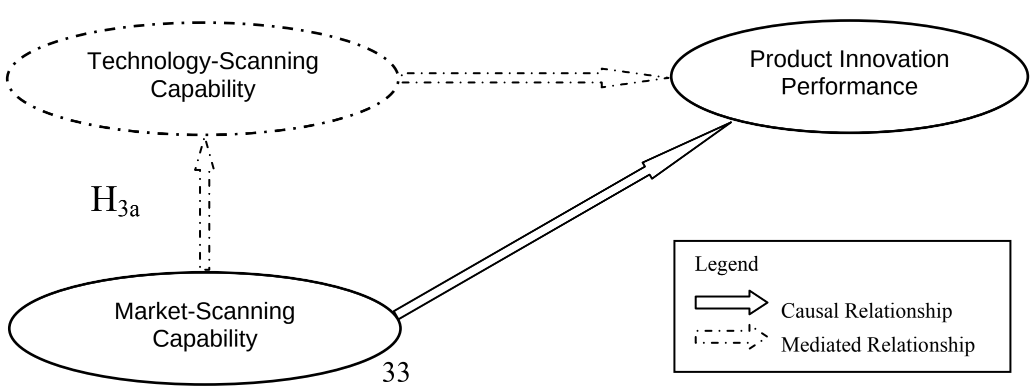
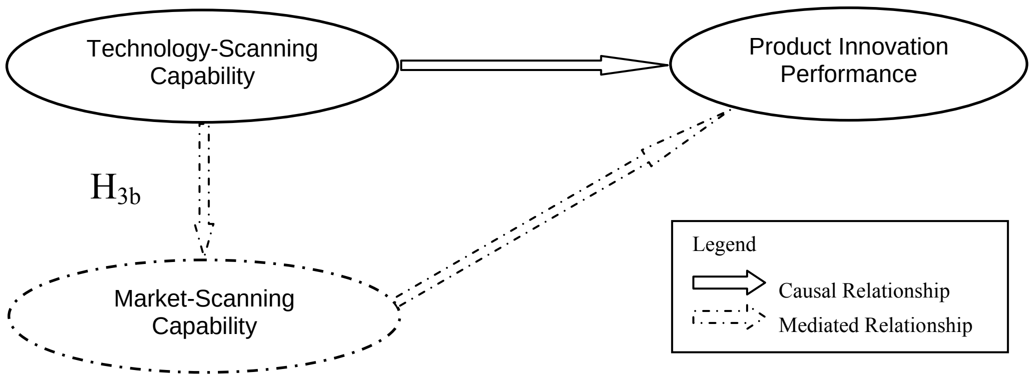


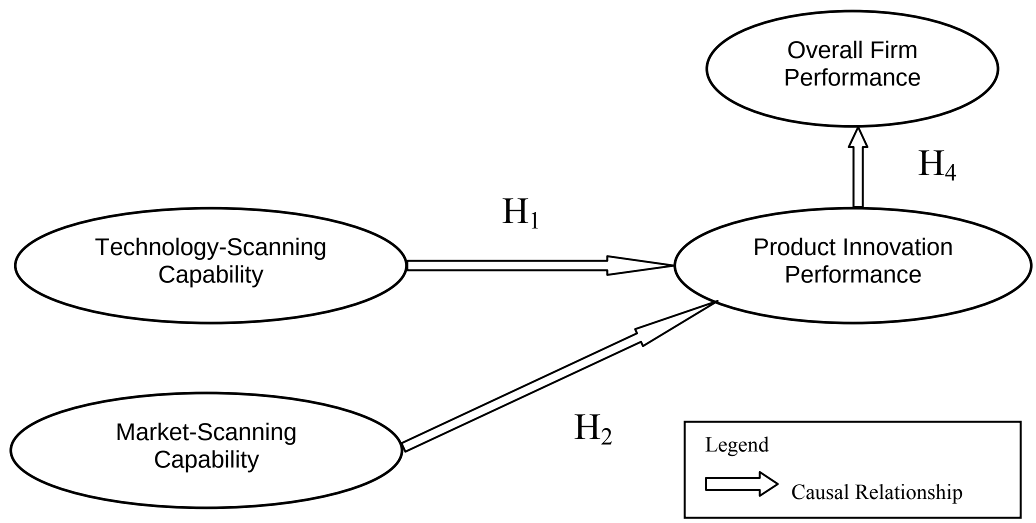
Figure 2-3 Research Model (Hypothesis H_{3b})



Following Díaz-Díaz et al. (2008), a two-staged approach was used to model the firm-level performance measures as dependent variables. Product innovation performance was directly influenced by the two intangible resources under consideration (i.e. market-scanning capability and technology-scanning capability), which, in turn, was modeled to influence the overall firm performance. This approach enabled the study to isolate many of the other factors that influence the final performance outcome of the firm but might not be of much importance for product innovation performance. Also, product innovation performance was considered a more sustainable outcome as it would take more time for a firm to lose such performance once it was achieved. The staged approach to model the dependent variable was captured in hypothesis H_4 and shown in Figure 2-4:

H_4: Firms with higher product innovation performance have higher overall firm performance.

Figure 2-4 Research Model (Hypothesis H_4)



2.5 Moderating Role of Environmental Turbulence

Technology-scanning and market-scanning activities derive the requisite information needed for innovation, either for new product development or for incremental improvement to the existing products. Outcome of these activities might be influenced by the level of turbulences present in the business environment in which firms operated. Dess and Beard (1984) described this environmental turbulence and dynamism as changes that were unpredictable, and difficult to plan for. However, different aspects of the environmental dynamism require that firms focus on the specific types of information based on their strategic mode (Miles et al. 1978; Jennings and Lumpkin 1992; Subramanian et al. 1993;

Rogers et al. 1999; Beal 2000). Strandholm and Kumar (2003, p. 420) indicated that “it may be more appropriate for an organization that is pursuing an efficiency-focused strategy to focus on the technological sector of the environment in order to identify those events that may affect the efficiency of their internal operations. Organizations that are pursuing a market-focused strategy may want to focus their resources on scanning the social/cultural sector in order to identify new market opportunities.” These authors, though narrow in their examination and had a different focus, identified an important phenomenon that supported the notion of examining the market and technology components of the environmental scanning activities separately. Irrespective of the strategies pursued and specific situations that firms were in, both technology turbulence and market turbulence were components of environmental turbulence.

2.5.1 Moderating Role of Technology Turbulence

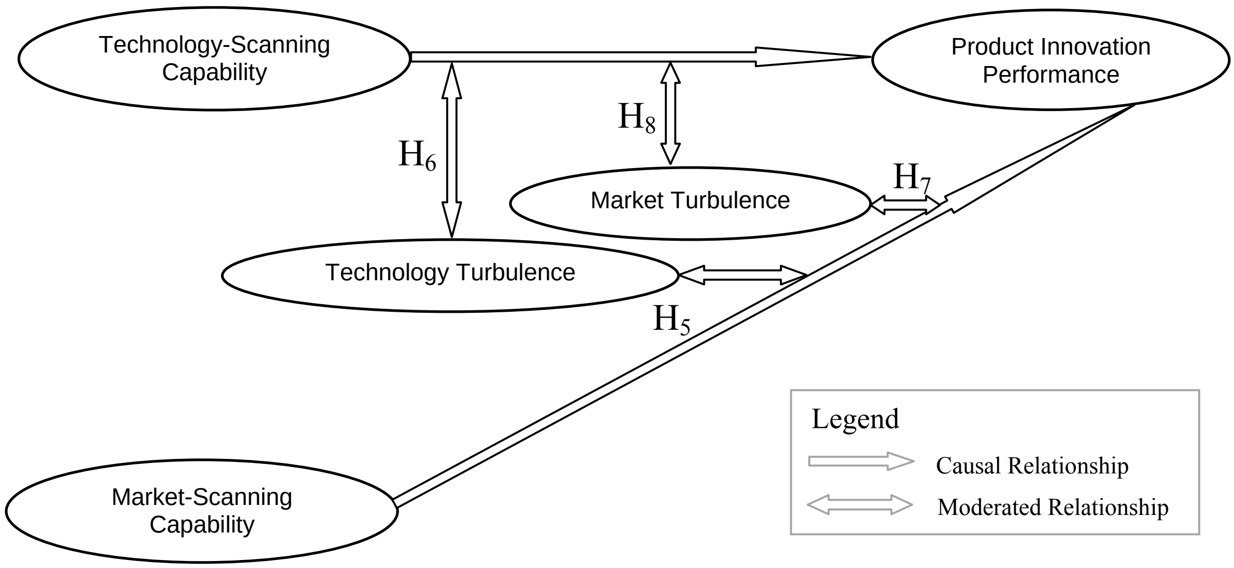
The relationships between dependent variables and independent variables are influenced by many factors, including environemntal turbulence. First, the role of technology turbulence was examined in affecting the causal relationships expected from resource-based theory. Slater and Narver (1994) defined technology turbulence as the changes in production and service technology, and changes in research and development activity. This was in line with Miller’s (1987) ‘dynamism’, and part of the Dess and Beard’s (1984) environmental turbulence. Market related information was more important for firms operating in the stable industrial sector than for industries that were characterized by rapidly changing technology

(Kohli and Jaworski 1990). On a same note, Slater and Narver (1994) proposed that the smaller the technology turbulence in a market, the greater the positive impact of market information on performance. For the current study, technology turbulence was expected to influence two relationships: the relationship between market-scanning capability and product innovation performance, and the relationship between technology-scanning capability and product innovation performance. A higher level of technology turbulence was expected to decrease the influence of market-scanning capability on product innovation performance. In other words, if an industry exhibited more technology turbulence, the less strength was expected between market-scanning capability and product innovation performance. A similar effect was expected on the other relationship – that is, higher level of technology turbulence was expected to decrease the influence of technology-scanning capability on product innovation performance. These reasoning led to the fifth and sixth hypotheses for the study, as shown below, also depicted in Figure 2-5. The overall influence of technology turbulence on the performance measure was expected to be negative – as was empirically tested in studies already mentioned:

H_5: The relationship between market-scanning capability and product innovation performance is negatively moderated by higher levels of technology turbulence.

H_6: The relationship between technology-scanning capability and product innovation performance is negatively moderated by higher levels of technology turbulence.

Figure 2-5 Research Model (Hypotheses H_5, H_6, H_7, H_8)



2.5.2 Moderating Role of Market Turbulence

Another factor that affects the relationship between independent variables (i.e. two scanning capabilities) and performance is market turbulence, which captures the market aspect of environmental turbulence. Miller (1987, p. 62) described the turbulence in the market as "change in diversity of production methods and marketing tactics required to cater to customers' needs." Kohli and Jaworski (1990) identified the same as part of environmental turbulence, consisting of changes in the profile of customers and in their preferences. Slater and Narver (1994) asserted that firms need to change their strategies in the face of changing customer needs – that is, market turbulence. When there were many changes in the type of customer and customer preferences, market-scanning capability would likely have little impact on the final outcome. A higher level of market turbulence would also result in weaker relationship between technology-scanning capability and product innovation performance; and the overall effect of market turbulence would be to reduce the performance. These led to seventh and eighth hypotheses of the study which were also depicted in Figure 2-5:

H_7: The relationship between market-scanning capability and product innovation performance is negatively moderated by higher levels of market turbulence.

H_8: The relationship between technology-scanning capability and product innovation performance is negatively moderated by higher levels of market turbulence.

2.6 Conclusion

The resource-based view of the firm anchored the causal relationships between the firm-level constructs of market-scanning capability, technology-scanning capability, product innovation performance, and overall firm performance. Another set of relationships also captured the moderation effects of environmental turbulence on the causal relationships. This model proposed that once firms knew what to do (as a result of the knowledge gained through market-scanning); they depended on another set of capability called technology-scanning to determine how to do it. Alternately, some firms might follow this cycle of sense-and-respond on a reverse sequence, i.e. they might identify some potential technology first and then, they might find out possible market applications for those technologies. The model also examined under what circumstances a specific firm might follow a particular sequence of sense-and-respond cycle.

Chapter 3
Research Methodology and Analysis

3.1 Research Methodology

Firms engage their heterogeneous and relatively immobile resources to exploit the heterogeneous customer demands and changing market forces using appropriate technological options. Given the findings of the literature review, an overall research model was presented (in Figure 2-1 through Figure 2-5 and combined in Figure 3-2), and the model was tested using empirical data collected through a national survey. This chapter presents the specific latent constructs used in the model and corresponding scales used to measure these constructs. The scales for technology-scanning capability and market-scanning capability were developed and reported in this study. Each of the other constructs used in the model was examined to discover whether there was a consensus regarding their definition and the measurement scale. The measures of these other latent constructs were identified from the literature for use in this study.

First, potential components of technology-scanning capability were found from the existing empirically based literature, and reported. Then, refinement and qualitative validation of individual items were performed for each of the scale items through an opinion survey of a convenience sample of academics and practitioners. After refinement, those items were included in a questionnaire delivered to a national sample of firms, along with other scales to measure the rest of the model constructs. Once the responses were received, a number of factor analyses were done to further refine the items of each scale. All the scales were also checked for their proposed structure and adjustments were made where deemed necessary.

3.2 Potential Scale Items for Technology-Scanning Capability (TechScan)

Empirical studies from extant literature were used to identify potential items for the technology-scanning capability scale. Specific studies on the success and failure factors of new product development were identified from the literature primarily on technology management and other related disciplines. National innovation surveys conducted by Statistics Canada (StatCan 1996; StatCan 1999; StatCan 2003) were also included for their comprehensiveness. Table 3-1 shows the list of the empirical studies that were reviewed, and Appendix A presents the detailed list of all the items. While reviewing the literature, a list of tasks and characteristics was first made from the selected publications. At this point, a close review of the list items matched the tasks and characteristics of the businesses, to group the items of similar nature. Different theoretical aspects of technology-scanning capability were also examined from the extant literature. With theoretical and empirical findings combined, five common themes were initially identified, and the specific individual tasks and characteristics were categorized under one of these five themes:

Table 3-1 List of Empirical Studies Identifying Specific Tasks Performed by Firms

Empirical Study	Publication	Sample Size	Country Focus	Industry	Focus of the Study
Cooper and Kleinschmidt (1995)	Journal of Product Innovation and Management	135 firms (out of 161 firms)	Germany, Denmark, US, Canada	Industrial	Success factors for new product innovation
Cooper and Kleinschmidt (1987)	Journal of Product Innovation and Management	203 projects in 125 firms (out of 205 firms)	Canada	Manufac-turing	Success factors for new product innovation
Statistics Canada (2003, 1999, 1996)	Statistics Canada	National Study	Canada	Mixed	Exploratory national statistics
Mishra et al. (1996)	Journal of Product Innovation and Management	144 firms (out of 310 firms)	Korea	Mixed	Success factors for new product
Benedetto (1999)	Journal of Product Innovation and Management	183 firms	PDMA practitioner members	Mixed	Success factors of product launch
Cooper (1979,1980)	Journal of Marketing	195 projects in 103 firms (177 firms)	Canada	Industrial	Industrial new product success and failure
Gerstenfeld (1976)	IEEE Transactions on Engineering Management	22 firms	West Germany	Industrial	Factors that influence project success and failure
Cooper (1975)	Industrial Marketing Management	150 firms	Canada	Mixed	Factors of failure for industrial products
Maidique and Zirger (1984)	IEEE Transactions on Engineering Management	59 participants in a symposium (out of 79 participants of an initial stage survey)	USA	Electronics Industry	Factors of success and failure of product innovation

1. Demonstrate strong management support for market-oriented technology-scanning; foster the required organizational culture, organizational environment, and processes, and provide necessary tools.
2. Demonstrate the use of numerous and diverse sources of information to identify major opportunities, and to anticipate threats as early as possible.
3. Demonstrate that the firm uses the findings from information processing activities to make certain operational and strategic decisions (i.e., firms respond to the findings of the technology-scanning process).
4. Demonstrate that the firm develops a shared sense of the future regarding technology and the overall industry.
5. Demonstrate that technology-scanning is goal-directed and is aligned with overall strategic objectives of the firm.

Raymond et al. (2001, p. 136) suggested that technology-scanning is a multi-dimensional activity that not only spans the technology domain but also includes other functional areas such as marketing and production. They also stated "scanning activities should be managed by someone who is accepted by the other members of the organization and who has decision-making authority," implying technology-scanning activities are of great importance, requiring access to the top management of the firm. Julien et al. (1999) used a four-dimensional model to measure technology-scanning: strategic orientation, types of information, sources of information, and scanning practices. They also included four other contingency factors in the measurement matrix: entrepreneur's profile, information network, firm's characteristics, and environmental uncertainty. Raymond et al. (2001) used an adapted model by replacing the 'strategic orientation' dimension in the Julien et al. (1999) model by 'scanning objective', and by adding a fifth contingency factor named 'technological attributes'. Van Wyk (1997) took a process view to define technology scanning, and offered the following four-step technology-scanning process:

1. Preparation: defining the landscape that has to be scanned, and setting up an agenda.
2. Observation: exploring the technological frontier.
3. Interpretation: identifying landmark technologies that serve as indicators of the main thrust of technological advance.
4. Evaluation: using the list of landmark technologies to identify technological potential and re-examine the company's own technological base.

The literature lacks consensus in terms of what should be the objectives of a technology-scanning process and of the specific steps that firms should follow in order to achieve the stated objectives. There is also another distinctive aspect of technology-scanning literature: Some are more focused on strategic and long-term perspectives (e.g.Van Wyk 1997), while others are narrow in their focus (e.g. Julien et al. 1999). For this study, a grounded approach was taken to develop the scale to measure the level of technology-scanning capability (TechScan) of a firm; the TechScan construct focuses on both strategic and operational components. Another important distinction of the TechScan construct is that it not only considers what options are available from a technological

Table 3-2 Possible Dimensions of Technology-Scanning Capability Scale

Technology-Scanning Dimensions	Justification / Benefit
1. Management Decision for Technology Scanning	
1a. Technology-scanning picks up where market orientation ends;	-This would emphasize that technology-scanning deal with relevant issues, i.e., it focuses on issues identified through market orientation practices.
1b. Emphasis on technology to find tangible ways to address the problems and needs of the customer or any internal factors;	-While other factors such as pricing might be a useful tool of competition, a technological answer to the problem, if available, often offers superior competitive advantage.
1c. Facilitate voluntary participation of potentially all employees;	-This is necessary to recognize the inherent nature of the innovation process is essentially voluntary at the core.
1d. Organizational readiness – HR policy, culture, processes and tools;	-Without support from policy, effective processes and needed tools, even the motivated group of employees can not perform an effective technology-scanning. So this organizational readiness is important.
2. Information Sources	
Technology-scanning should exploit all potential sources of information: employees, users, customers, manufacturers, suppliers, distributors and others stakeholders.	-This would increase the likelihood that no opportunities are missed, including all the weak signals that come through the research publications.
3. Technology-Scanning Responsiveness	
Responsiveness to technology-scanning – Usage level of outcome	-The justification of the allocation of resources for finding superior technological solution is achieved only if the findings trigger a set of decisions leading to the evaluation and implementation of the potential new technological solutions.
4. Specific Goals Pursued Through Technology-Scanning	
4a. Synergy with technological trend in the market place is emphasized;	-This would stress that firms' innovation efforts benefit from the synergistic effect of the industry situation.
4b. Compatibility with firm's existing technologies, resources and competencies;	-This would emphasize that firms' innovation efforts benefit from compatibility with the other functional areas and competencies of the firm.
4c. Exploitation of technology portfolio in new international market – for both acquisition and sales;	-A specific focus on internationalization will enable the firm to maximize the return from its current resource portfolio through value appropriations.
4d. Distinguish between ways to make incremental vs. radical innovation;	-Both incremental and radical innovation has distinct influence on the profitability and overall market share of the firms. Based on the firm's strategic positioning and other factors, focusing on either incremental or radical or both types of innovation might be useful for the firm.
4e. Attention paid to cost reduction.	-The cost that the firm incurs in different stages of development of a product has an important influence on the end price of the product; more true when the market is relatively competitive. So paying attention to restrain these incremental costs helps firms compete effectively.
5. Level of Shared Sense of Future	
Technology-scanning would guide a shared sense of the future regarding where technology and overall market is heading and how the firm positions itself within the broader context.	-Need for a shared sense would stress that the firm's employees participate and contribute in creating the vision of the future.

viewpoint, but also considers which of the possible options are more aligned with the market trend. In other words, a strong technology-scanning capability within the firm should enable firms to assess the alternative technological options – that is, it should enable firms to find out which option is top-ranked – so that managers can make an informed decision. The extant literature was used to analyze, and propose, the common minimum characteristics or dimensions for technology-scanning activities within a firm. These characteristics are discussed in the following sections, and a summary is presented in Table 3-2.

3.3 Dimension I: Management Support for Market-Oriented Technology Scanning

Many authors identified management support as an important factor in the development of technology-scanning (e.g. Peters 1991; Cooper and Kleinschmidt 1995; Mishra et al. 1996). When a firm's top management recognize the importance of technology-scanning, they are likely to better facilitate the proper execution of the processes that aid technology-scanning. How the resources of a firm are engaged at a specific time is usually decided within an overall strategy framework. All the firms in a given industry are faced with similar factors in the business environment; they compete for the same super-set of customers and even in some cases, these firms hold similar types of tangible resources. However, not all the firms perform the same way in response to the changes in customer choices or changes in environmental stimuli. This becomes the outcome because different firms approach the issue of value creation for its customers in different ways based on their strategic orientations. A firm with mature approach to technology-scanning is expected to view competition in the market as an ongoing process of identification of methods, techniques and processes that enable the firm to address its customers' needs and problems effectively and in a cost-competitive way. Also, these firms would be constantly on the lookout to define new markets and re-define the existing markets based on their insight of future technological developments. The firms would also make policies and organize activities in a way that emphasize an institutional climate of creativity, innovation, and voluntary participation of all employees. The details of this component are described in the following sections.

3.3.1 Technology-Scanning May Start Where Market Orientation Ends

One of the major aspects of market orientation is the firm's response to the market information that it collects through market orientation practices. Jaworski and Kohli (1996, p. 122) emphasized this component in separating market orientation from another parallel concept of market information processing by saying: "They are distinct in that market orientation also includes responsiveness – the use of market information for making decisions and taking actions." Technology-scanning may trigger from this need to respond to market information. Once a problem, or a need of the customer, is identified through market orientation processes, technology-scanning capability allows the firm to find a suitable way to address the problem and fulfill the need of the customer. Extant empirical research (Gerstenfeld 1976; Cooper 1979; Cooper 1980; Maidique and Zirger 1984; Cooper and

Kleinschmidt 1987; Cooper and Kleinschmidt 1995; Mishra et al. 1996; Benedetto 1999; StatCan 2003) pointed to evidence that factors responsible for a higher level of market orientation are often a precondition for a successful new product development program. Benedetto (1999) examined whether firms had adequate marketing skills and resources; and Cooper and Kleinschmidt (1987) asked whether a firm's new products solved a problem for a customer who had difficutly with a competitor's product.

3.3.2 Focus on Technology

When faced with a new challenge – such as new customer needs, changing pattern in customer preference, regulatory change, or environmental concerns – some firms emphasize exploring the technological options that might be used as opposed to resorting to other tools of competition, such as price manipulation and advertisement. This is not to say that those other tools are not considered, but an emphasis on technology may be predominant in the culture of certain firms compared with others in a similar situation. Other than this inherent nature of a firm's management choices and practices, internal factors might, due to inertia, also lead to dependence on a certain technology. However, when the firm has a culture of technological alertness shown by many firms, then unsatisfactory operations, inefficient production processes, or obsolete technologies being used may lead to a search for new technological solutions to mitigate the problems. Empirical research performed by Mishra et al. (1996) and Statistics Canada (1996) support this sub-dimension to be included in the technology-scanning capability scale. Mishra et al. (1996) examined whether firms considered the newness of a certain technology when making decisions.

3.3.3 Facilitation of Voluntary Participation of Employees

In all the business processes where the members of an organization participate, the process of innovation is the more uncertain in that its outcome is not known. The managers may have some reasonable expectations about the outcome of an innovation effort, but the process has its inherent uncertainty. Once the goal of an innovation effort is defined by identifying the problems and needs of the customers through market orientation processes, individual members identify or locate the potential techniques and technologies that can be used to satisfy those identified customer problems and needs. Peters (1991, p. 14-15) characterize these processes within a modern firm as follows: "By definition, you can never force anyone to be innovative, to engage in continuous improvement, to use their heads to make things better every day. Thus …we have no option but to treat everyone as volunteers".

Leavitt (1996), in describing the organizational conditions for productive and innovative behavior, asserted that the following four characteristics are important: a democratic approach, a competitive atmosphere, leadership, and task orientation. While technology-scanning emphasizes task orientation when it is triggered by some market information, Leavitt's other three criteria result in a voluntary nature of the organization as these conditions try to improve motivation of the employees. In essence, in order for the individual members of the organization to engage in effective technology-scanning, firms encourage their employees to contribute voluntarily. Empirical survey designs by Cooper and Kleinschmidt (1995), Statistics Canada (1996) and Statistics Canada (2003) provided evidence that this item was often measured; for example, Cooper and Kleinschmidt (1995) examined whether firms gave their employees time-off for 'creative things.'

3.3.4 Organizational Readiness – HR Policy, Culture, Processes and Tools

Part of management's job is to provide such a climate within the firm, both in terms of policy and infrastructure, which helps employees to contribute in an effective manner. Moreover, employees may be recruited in a way to make the experience portfolio of the workforce of the firm as diverse as possible. This strategy allows the firm to benefit from the technology brokering effect (Hargadon 2005) that evolves naturally when the personnel have a knowledge-base that pertains to many industries. Moreover, firms create multi-disciplinary teams for new product development in order to take advantage of different viewpoints of the employees from different functional areas (Cooper and Kleinschmidt 1995). Once suitable personnel are hired, firms support them with: proper tools, such as access to data mining software; processes, such as formal technology assessment processes; and policies, such as providing support for employees to attend conferences, seminars and tradeshows – thus ensuring effective information gathering and processing for the firms. Empirical researches designed by Cooper and Kleinschmidt (1995), Cooper and Kleinschmidt (1987), Maidique and Zirger (1984), Gerstenfeld (1976), Statistics Canada (2003), Statistics Canada (1999), Statistics Canada (1996) supported this sub-dimension. For example, Statistics Canada (2003) queried whether firms offered off-site training to workers in order to keep skills current, or whether firms maintained databases on good work practices, lessons learned from different projects, or product development efforts.

3.4 Dimension II: Use of Numerous and Diverse Sources of Information

As products are becoming more dependent on technology and as product life cycles are being shortened (Clark et al. 1984; Cravens 1986; Achrol 1991; Sood and Tellis 2005), R&D departments of producers and manufacturers have less time to spend on any one specific product. This time constraint and other competitive forces encourage firms to seek external information to discover technological development elsewhere which might be useful to them. Among the researchers who investigated other sources of innovation differing from conventional line of thought that says ‘only manufacturers innovate’, von Hippel (1988) argued that there are various constituents in any product innovation; for example: users, manufacturers, suppliers and distributors. All these constituents have differing levels of incentives and profiting mechanisms when evaluating an improvement in the innovation in question. von Hippel also argued that these constituents have access to varying degrees of resources and expertise available to themselves for improving an existing product or for innovating a new product that fills a market need for an existing or yet-to-be-articulated demand. By identifying more sources to look for information and ideas for innovation, these findings help those firms searching for new ways to satisfy their customers. The sources for ideas are many: employees, users, customers, manufacturers, suppliers, distributors, research community, competitors, professional associations, business and regular press, government regulators and other stakeholders. Strong support exists for this characteristic of the firm's behavior according to many empirical research publications (Maidique and Zirger 1984; Cooper and Kleinschmidt 1987; Cooper and Kleinschmidt 1995; StatCan 1996; StatCan 1999; StatCan 2003). Cooper and Kleinschmidt (1995) examined whether customers were involved in an innovation effort. Maidique and Zirger (1984) asked their participants whether they had more interaction with users in the development stage; they also examined whether project teams interfaced more with external resources and whether innovations depended more on technologies that were developed externally.

3.5 Dimension III: Responsiveness to Technology Scanning – Usage Level of Outcomes

A firm may use the result of technology-scanning activities in different situations – to aid in day-to-day operational decision making and to aid in long-term strategic decision making. In all the stages of the business execution, managers are faced with making decisions, choosing among alternatives. The maturity of the technology-scanning activities becomes clear if the outcome of the process is used as an input for various decision points. A high level of technology-scanning activities can serve as an effective decision support system for management. Among the empirical studies reviewed, Statistics Canada (2003) asked participants whether they purchased rights to use patents and non-patented inventions, licenses, know-how, trademarks, software and other types of knowledge from others for the development of new or significantly improved products and processes. Such purchasing would be a response to information that the firm might have gathered, a characteristic for which Statistics Canada (1999) also lent support.

3.6 Dimension IV: Extent to Which a Shared Sense of Future is Developed

Senge (1990) identified 'building a shared vision' as one of the five component technologies that enabled organizational learning. Firm's technology-scanning activities facilitate the building of a shared vision about the future of the firm and the firm's role within the industry or market. This shared sense of destiny would enable the firm to engage its resources towards a focused direction in a coordinated way. Some of the measurement of these processes would be quantitative in nature, for example, whether the firm processes and activities connect different functional areas; some others however would be qualitative in nature, for example, whether the individuals often disagree with colleagues from other functional areas and teams. Among the authors that performed empirical reviews, Benedetto (1999), Cooper and Kleinschmidt (1995), Maidique and Zirger (1984), Statistics Canada (2003), Statistics Canada (1999) and Statistics Canada (1996) supported this dimension for technology-scanning. Benedetto (1999) examined whether interdepartmental committees were set up to allow departments to engage in joint decision making. Statistics Canada (1996) asked participants how much consensus decision making was done. Maidique and Zirger (1984) examined whether innovation teams had more project reviews during development and commercialization than at other times. This component of technology-scanning construct measured how strongly different functional areas of a firm were integrated with a single vision.

3.7 Dimension V: Technology-Scanning is Goal Directed

Aside from the general focus of the technological aspect of problem solving and of finding answers in the technological field, firms try to achieve certain goals during their innovation efforts. The literature from technology diffusion, innovation, economics, marketing and international business lent support in identifying the specific goals to which firms pay specific attention (Cooper 1980; Maidique and Zirger 1984; Cooper and Kleinschmidt 1995; StatCan 1996; Benedetto 1999; StatCan 1999). These specific goals are: a) to pay attention to technology trend, b) to be compatible with current competences, c) to exploit the current technology portfolio, d) to distinguish between incremental and radical innovation, and e) to pay special attention to the cost reduction implications of technological development – all of which are detailed in the following sub-sections.

3.7.1 Synergy with Technological Trend in the Marketplace is Emphasized

Firms use technological innovation, among other organizational factors, to solve an identified customer-related problem or to design a new product. To perform effective innovation, firms need to stress that all possible sources of information are used to gather the innovation ideas. Firms might not find a readily available technological solution to an identified problem; instead, there might be several potential candidates for future investigation. Given these scenarios, firms decide to choose one of the competing alternatives to implement or to investigate. A strong technology-scanning capability may enable the firm to identify the complementarities of technologies so that the right decision can be made, thereby taking advantage of existing trends in the market and increasing the likelihood of improved adoption rate of their offerings and innovation success.

Success of a particular new product or an innovation that is introduced to the market depends highly on its level of adoption among the prospective customer base, an adoption that in turn depends on other factors. Some of these factors can be endogenous to the innovation itself, or they can be exogenous to the specific innovation in question. While it is difficult to measure the impact of exogenous factors on the success of an innovation, they are generally recognized as responsible for widespread, across-the-board adoption of an innovation. Adoption of a product in a certain industry often depends on the adoption of some other related product within the same industry. Similarly, developments in other industrial sectors might also influence innovation in a given industry.[1] This inter-dependence

[1] Widespread adoption of portable computing devices (e.g., laptop computers, PDAs, smartphones from different manufacturers) would not be possible without improved technologies of energy storage devices with high power storage density. Also, currently there is a new push from different companies to offer video programming through portable mobile devices. For this later innovation to become a market success there will be a need for a high bandwidth mobile data and even higher energy density devices; otherwise video usage of the portable devices (in addition to the existing uses of voice, email, digital assistants, etc) would dissipate power quickly, essentially reducing the viability of these devices to the consumers.

among different innovations in a single industry or multiple industries makes the study of technology-change and its role on the success of a certain innovation more challenging and interesting.

As described by Rosenberg (1982, p. 60), the complementarities of different innovations can be better understood by taking a systems perspective. Within any socio-technical system, the combined effect of stand-alone separate improvements has a much greater effect than the cumulative individual effects when they are considered separately, as was supported by Rosenberg: "It is the characteristic of a system that improvements in performance in one part are of limited significance without simultaneous improvements in other parts, just as the auditory benefits of a high-quality amplifier are lost when it is connected to a hi-fi set with a low-quality loud-speaker." Whenever there is an innovation in a specific industry, other innovations are taking place with or without the involvement of the same manufacturer, which has a complementary effect on the productivity of the first innovation. This is likely the reason why even apparently spectacular breakthroughs do not always bring exciting changes instantaneously – only a gradually rising productivity and adoption curve is observed in many cases. Therefore, the combined effects of several complementary innovations and their improvements within a technology system are immense; one invention sharply raises the utility of another invention.

Rosenberg (1982, p. 61) further explained: "The role of complementarities relationship may be further observed, in finer detail, in the history of individual innovations.

Sometimes a particular innovation has to await the availability of a specific complementary input or component; and sometimes the evident need for the input is sufficient to lead to its invention; and sometimes the input, when it is fully developed, is found to have uses and applications of a totally unanticipated – or at least unintended – sort.” This argument suggests that it is not enough to contemplate the usefulness of a stand-alone product; rather manufacturers have to think about the synergistic dynamics of the product in question when integrated with other existing and anticipated future products in the market. Since the widespread adoption eventually defines the success of the innovation, for marketing success the synergies are sometimes more important than the stand-alone features.

Innovation in one industry is usually not kept within the boundary of that industry; rather it spills over to other related or unrelated industries through interaction among profit-seeking economic agents or simple diffusion over time (Rosenberg 1982). Technology changes in one industry may act as a source of innovation in other industries, some changes taking more time than others. The innovations that are induced in an industry by changes in other industries sometimes lead to incremental improvements in existing products and processes; sometimes however, they disrupt the existing product markets and introduce drastically different and improved products, replacing the old ways of doing things. This phenomenon suggests that the managers and analysts should broaden the scope of technology-scanning activities beyond the boundary of their specific industry and should not exclude the technology developments emerging in seemingly unrelated industries. When an innovation by a firm is in line with the trend in the market place, it is more attractive in that it needs much less promotion, marketing, and sales efforts than when it is not. Also, the literature on increasing return economics (Arthur 1989) and technology diffusion (Geroski 2000) suggest that the development effort which fits with technology trends has more potential to become a success in the market place. Empirical research designs reported by Cooper (1980), Maidique and Zirger (1984), Statistics Canada (2003) and Statistics Canada (1999) lent support for this dimension. Maidique and Zirger (1984) examined whether the chosen technological options of firms are closer to the state-of-the-art technologies. Statistics Canada (1999) asked whether firms emphasize active involvement in developing new industry-wide standards to bring their internal technological knowledge and development efforts in-line with the existing trends in the market place.

3.7.2 Compatibility with Firm's Existing Technologies and Resources

Just like the complementary effects of a chosen technique are important with respect to external environment, firms are also concerned with the compatibility with their existing competencies. When a broad-level decision regarding future technological path is made, these internal concerns should be considered. Issues of compatibility of the chosen technology with the existing resources of the firm, such as marketing, sales and distribution, management and market research skills, and production facilities (Maidique and Zirger 1984; Stuart and Abetti 1987) have to be investigated. First, firms consider the existing technological resources – know-how, investment and ownership (if any) – while deciding on new innovation pathways in relevant cases.[2] Issues regarding both complementarities with existing technology competences and complementarities of R&D with other functional areas would be considered.

Recently, Song et al. (2005) examined marketing capabilities, technological capabilities and their complementarities (interaction); they found that the role of the complementarities was more important in the high-turbulence environment than in the low. Compatibility with firm's existing resources has strong support in the empirical research reported by Benedetto (1999), Cooper and Kleinschmidt (1995), Cooper and Kleinschmidt (1987), Cooper (1979), Maidique and Zirger (1984), Statistics Canada (2003), and Statistics Canada (1996). Cooper (1980) found that firms with successful product development efforts had compatible engineering skills. Cooper and Kleinschmidt (1980) examined whether firms had a good fit between the needs of the project and R&D, or product development skills and resources. Maidique and Zirger (1984) reported compatible sales force and distribution resources and skills in firms that have successful product development effort.

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[2] For example, think about a traditional telephone company when it was considering possible options to offer broadband internet connectivity. Given that there were two possible ways to introduce this new product – DSL and Cable – an existing telephone company would benefit from adopting DSL as the technology choice, if all other technological benefits were assumed to be equal. This was so, since the technology itself would have been known to the company and all other functional areas would have existing competencies that were synergistic to the choice of DSL technology that made use of the existing telephone network that the firm already owned.

Figure 3-1 Product-Market Matrix: Four Strategies

	Existing Markets	New Markets
Existing Products	A. Improve value and cost	C. Adapt know-how to new markets
New Products	B. Leap forward in value and cost	D. Radical product and market diversification

Source: Erickson et al. (1990)

3.7.3 Exploitation of Technology Portfolio in New International Market

Erickson et al. (1990) described a product-market matrix for presenting the four strategies that a firm can pursue when exploiting full potential in market and product domains, as shown in Figure 3-1. Using geographical areas as the definition of market, these four strategies can be used to discuss how the firm approaches the issue of engaging in new markets in international locations. From strategic point of view, all four cells in the figure offer different levels of opportunities and risks in terms of the investment requirement and return potential from the investment. Cell A indicates an opportunity for ongoing cash flow from the current products being sold in existing markets. Strategies related to Cell B and Cell C offer new possibilities with reasonable risks as firms enter into new endeavors either with known products or in a known market – so the firm can depend on its existing competences to a certain extent. Among the four strategies, Cell D offers more risk as the firm needs to acquire new market competences and new technological competences in this case. While exploring the options for internationalization of products and services, firms have traditionally considered the 'psychic' closeness of the target market as a major decision factor. A slightly overlapping yet distinct criterion that distinguishes different international markets is the issue of susceptibility to new and technologically advanced products. Markets in Japan, Western Europe, and South Korea are characterized by such susceptibility. Thus, when a more advanced product is developed using current competences, the firm may consider certain international markets for initial kick-off, sometimes, before introducing the product in the domestic market.

'Born-global' and 'knowledge-intensive' firms (Bell et al. 2001) often target international markets when they introduce breakthrough products and technologies, thus defying the assumption that Cell D offers more risk. Alternately, a domestically established firm may seek to acquire new technologies by collaborating with or acquiring an international firm. The pervasive spread of ICT technologies – such as www, email, fax, RSS, blog, twitter, social networking tools – has enabled firms to gain access to the information about new international markets, allowing identification of new market segments that might be ripe for exploitation using the existing technology portfolio of the firm. Technology-scanning capability should enable firms to identify the existing products and services and relate them to possible new international markets. Three consecutive surveys on innovation by Statistics Canada (2003, 1999, 1996) examined this specific dimension. For example, Statistics Canada (1996) asked whether innovation opens up new international markets, and Statistics Canada (1999) examined if innovations helped increase firm's domestic market share.

3.7.4 Distinguish Between Ways to Make Incremental vs. Radical Innovation

Among the categories of innovation found in literature, the dichotomization of innovation as incremental and radical types is prominent. There are many aspects of this classification of innovation – it could be based on the technologies that firms use, or it could be based on the type of customer choices and needs being addressed. However, there is another side to this dichotomization of innovation with respect to the way the companies appropriate profit from the introduced innovations: When a radically new innovation is introduced by a firm, it needs to employ relatively abundant resources to make the radical innovation known to the potential customers – making the marketing and sales effort expensive. Once the innovation is introduced, competitors start crowding the same market segment with other similar and 'me too' products and services. Due to both competitor pressure and high initial cost for invention and marketing, the profit from initial radical innovation may not be as high as expected for the firm who introduced it first. Compared with radical innovation, incremental innovations face fewer difficulties and lower cost in terms of both development cost and market creation and penetration. Hence, incremental innovation could yield a higher rate of return and profitability. Harrington (1995) provides empirical evidence showing that continual (incremental) process improvements provide higher gain than achieved with breakthrough (radical) process improvements.

Based on the discussion presented above, it is evident that while a firm would want to continue innovating through radical products and processes to gain access to new uncharted markets and production environment, it also needs to focus on finding techniques and technologies to introduce incremental innovations to the existing products and services. Both of these types of innovations would benefit a firm in two distinct ways, and which one becomes the more important would depend on the strategy it pursues. In general, it can be said that the technology-scanning capability enables the firm to discriminate between the two types of innovation. Cooper and Kleinschmidt (1987), Cooper (1980, 1979), Maidique and Zirger (1984), Statistics Canada (2003), Statistics Canada (1999) and Statistics Canada (1996) reported that empirical researches lent support to this technology-scanning sub-dimension. Among these studies, Maidique and Zirger (1984) found that many product developments had become radical with respect to world technology.

3.7.5 Specific Attention is Paid to Achieve Cost Reduction in Existing Products

Technological development and the adoption of new technologies enable a firm to reduce costs in different stages of the product life-cycle. The incremental cost-reductions are important factors determining the price that customers pay for a product, especially when competition is high. Therefore, firms give special attention to direct and indirect cost reduction options during development stages so that they have the needed flexibility in pricing products and services. Empirical research designs by Cooper (1980, 1979), Statistics Canada (2003), Statistics Canada (1999) and Statistics Canada (1996) supported this technology-scanning sub-dimension to be included in the scale. Cooper (1980) queried whether new products enable customers to reduce costs. Statistics Canada (1996) examined whether innovations enable firms to reduce their production cost by reducing unit labor cost and production time, and by cutting consumption of materials and energy.

3.8 Refining TechScan Items through Opinion Survey of Experts and Practitioners

Once the findings from both the theoretical and the empirical literature were combined, the next step was to validate these dimensions and items listed in

Table **3-2** through in-person survey of experts and practitioners. A convenience sample of 10 researchers and practitioners were interviewed to get their view on the individual scale items. This step of the exploratory stage helped refine the vocabulary and actual questions to be asked in the final confirmatory stage questionnaire (Aaker et al. 2001). The list of experts, who had diverse work experiences, represented a total of 26 industries; Table 3-3 shows the demographics of those interviewed. It is evident from the list that the interviewees represented a wide variety of industries and sectors; their input was used to generalize the questions as much as possible. As can be seen from the results, however, the variety of their affiliation and experiences did not result in much variance in the findings while surveying their opinions. One explanation of this could be based on the solid theoretical foundation of these dimensions and their appropriateness for the topic on question. A structured survey was conducted using a set of questions in which participants were asked to rate different components and their sub-components of technology-scanning construct. Appendix B and C show the specific instruments used during the opinion survey.

Table 3-3 Demographics of the Experts Surveyed to Refine TechScan Scale Items

#	Academic & Professional Qualification	Years of Experience	Types of firms worked with	Positions Held
1	MBA, Postgraduate	20 years	Manufacturing, Telecom, Retail, Real Estate	President
2	M.Sc., MBA (P.Eng.)	25 years	High-tech, Power generation, Nuclear	Director, Consultant
3	Bachelor	7 years	Manufacturing, Grandfather Clock Company	President
4	Bachelor (Writer / Editor)	13 years (6 yrs in software, 7 in comm.)	Software, financial, medical, hardware	Partner / Owner; Manager, Technical Publications
5	B.Sc., MMSci	9.5 years	Automotive, Logistics , Packaging	Production Control Specialist
6	M.Sc. (P.Eng.)	9 years (7 full time, 2 part time)	Medical Research Industry	Technical Manager, R&D Engineer
7	MBA	15 years in industries, 11 in consulting	Petrochemical, Base Chemicals, Natural Gas, Food, Insurance	Systems Analyst, Lecturer
8	Bachelor	2 years	Green Technologies	Entrepreneur
9	PhD	12 years	R&D, IT Development	Research Scientist, Design Engg.
10	Bachelor	30 years	Aeronautical, Amphibious Vehicle, Gear Industry	CEO, President, Design Engineer

The findings from this opinion survey stage were supportive of what was proposed based on the relevant theoretical and empirical literature. A summary of the findings of this stage is included in Appendix D. The average score for each of the items was supportive, and these results were retained at the conceptual level. However, after further consideration and review, a few of the items were merged together for clarity and to avoid redundancy. The twenty-one items in Appendix C were modified and rewritten, and finally sixteen items for TechScan scale were generated. These were again examined for improvement in wording. Table 3-4 shows the final items as they were used in the national survey. Note that the items in this table are not grouped in five theoretical dimensions as reported earlier, since these final sixteen items were subjected to exploratory factor analysis (EFA) to find the inherent groupings of the data and to examine whether the possible new groupings suggested by the data made more sense than the groupings listed in Appendix C.

3.9 Selection of Measurement Scales for Other Latent Variables

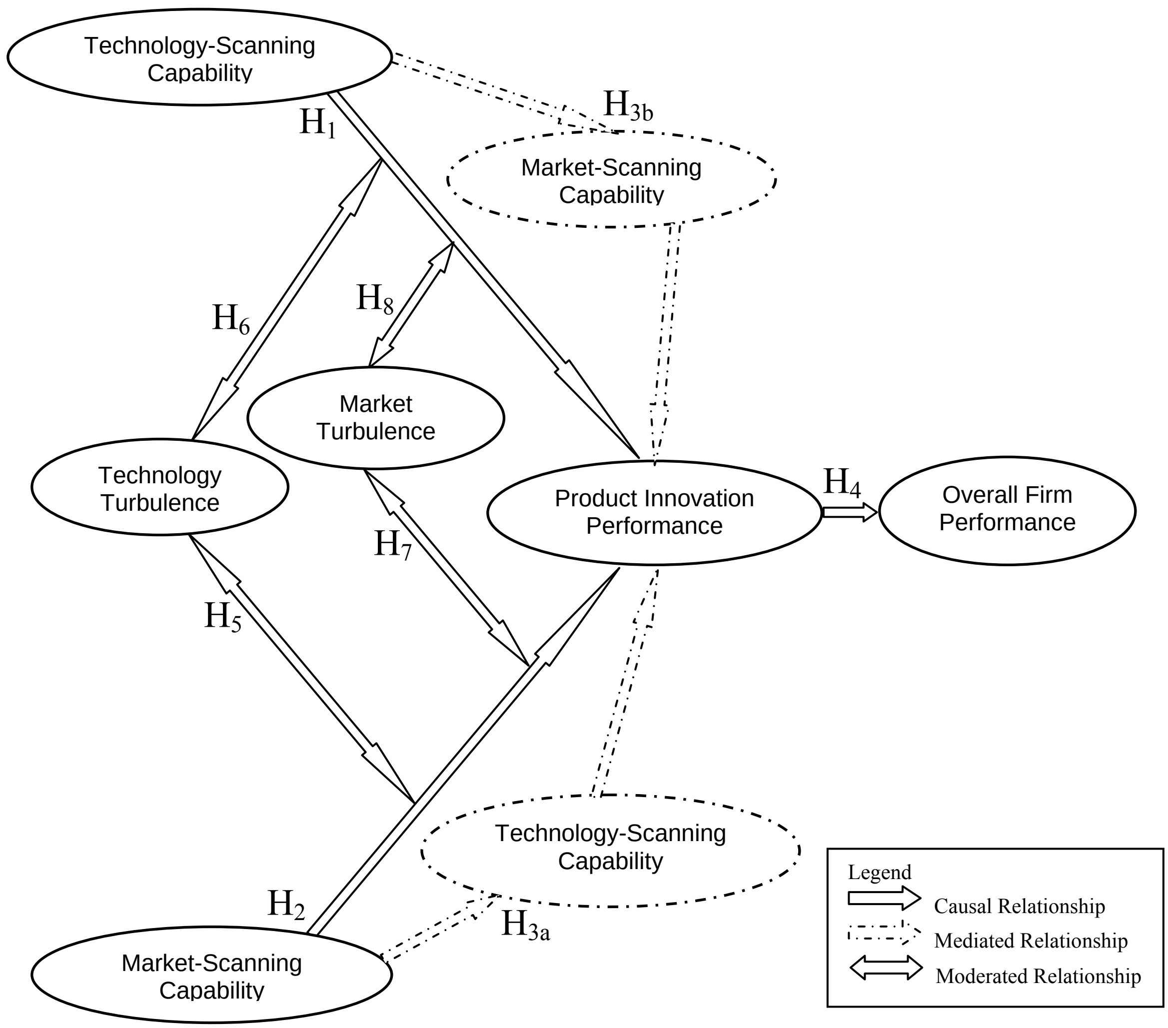
Figure 2-1 to Figure 2-5 showed the development of specific hypotheses and Figure 3-2 shows the overall research model, illustrating interactions among four main latent constructs and two moderating variables under consideration. These four latent constructs are market-scanning capability, technology-scanning capability, product innovation performance, and overall firm performance. Additionally, there are two other latent constructs, market turbulence and technology turbulence, to capture overall environmental turbulence.

Table 3-4 Technology-Scanning Capability (TechScan) Scale Items

#	**Item Code**	**Items**
1	TSC01	The market drives our search for new technological solutions.
2	TSC02	Technology plays an important role in our approach to tackling an issue, whenever appropriate.
3	TSC03	Our company encourages employees to explore new technological ideas voluntarily.
4	TSC04	Our company makes policies, introduces processes and provides tools to enable employees to explore new technologies.
5	TSC05	Our company uses the information available *within the organization* when searching for new technological solutions.
6	TSC06	Our company uses the information available *among the members of the external network of the organization* when searching for new technological solutions.
7	TSC07	Our company gathers information from global sources when searching for new technological solutions.
8	TSC08	Our company responds well to any technology information that has a strategic implication.
9	TSC09	Our company responds well to any technology information that has an operational implication.
10	TSC10	Employees from different functional areas usually agree on the development path of our company's technology.
11	TSC11	Our company usually makes an attempt to co-develop future development plans about its technology with other players in our business network.
12	TSC12	Our company looks for synergy of company's product offerings with existing technological trends in the market.
13	TSC13	Whenever possible, our company actively seeks to ensure compatibility with its existing technologies, resources and competencies while adopting a new technology.
14	TSC14	Our company seeks to exploit new international markets through both acquisition and sale of intellectual property.
15	TSC15	Our company consciously engages in both types of innovation, namely incremental and breakthrough innovation.
16	TSC16	While considering new technological options, our company gives specific attention to achieve cost reduction in existing products.

A suitable scale for technology-scanning capability with the scope used in this study was absent in the literature; hence, a significant part of the empirical research was to develop a scale for technology-scanning capability based on the theoretical findings reported above. A scale for market-scanning capability with the context of this study was also absent, though scales to measure a related concept of market orientation is abundant in the literature. Hence, the relevant items from various market orientation scales were used to develop a new scale for market-scanning capability. Other four latent constructs in the model were measured using existing scales in the literature, and presented next. Of the total six constructs, market-scanning capability (MktScan) and technology-scanning capability (TechScan) constructs are independent variables in the model. The model uses two dependent variables captured by product innovation performance (PIP) and overall firm performance (OFP). The additional two constructs, which measure technological turbulence (TechTurb) and market turbulence (MktTurb) of the business environment of the firm, act as moderator variables as shown in the overall research model in Figure 3-2.

Figure 3-2 Overall Research Model



3.9.1 Measurement Scale for Market-Scanning Capability (MktScan)

Several scales had been proposed and discussed in the literature to measure the market orientation of a firm. Kohli and Jaworski (1990) used the MARKOR scale and Narver and Slater (1990) proposed the MKTOR scale to measure market orientation. Kohli and Jaworski (1990) described market orientation as “the organization-wide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across departments, and organization-wide responsiveness to it”. According to Narver and Slater (1990), market orientation comprises three behavioral components – customer orientation, competitor orientation and inter-functional co-ordination. They also described market orientation as an “organizational culture that effectively and efficiently creates” these behaviors. Han et al. (1998) used a combination of the existing scales from the literature, primarily influenced by Narver and Slater (1990), when examining the role of innovation in the relationship between market orientation and performance. Also, Narver et al. (2004) described two separate scales to measure the market orientation of a firm – proactive market orientation and reactive market orientation. In order to identify the items for a scale to measure firm-level market-scanning capability (MktScan) of firms, the following three market orientation scales were used: the market orientation scale proposed by Narver and Slater (1990), proactive market orientation scale proposed by Narver et al. (2004) and reactive market orientation scale used by Narver et al. (2004). The survey included twenty four items that were directly taken from one of the above-mentioned scales of market orientation. However, only items that were closer to the ‘face-validity’ of market-scanning capability were considered as potential items for the scale. Table 3-5 shows a list of seventeen items that were deemed as suitable for market-scanning capability and later these items were used to run exploratory factor analysis to find the underlying factors for the scale, if any.

Table 3-5 Market-Scanning Capability (MktScan) Scale Items

#	Item Code	Items
1	MSC01	We help our customers anticipate developments in their markets.
2	MSC02	We continuously try to discover additional needs of our customers of which they are unaware.
3	MSC03	We brainstorm on how customers use our products and services.
4	MSC04	We search for opportunities in areas where customers have a difficult time expressing their needs.
5	MSC05	We work closely with lead users who try to recognize customer needs months or even years before the majority of the market may recognize them.
6	MSC06	We extrapolate key trends to gain insight into what users in a current market will need in the future.
7	MSC07	We constantly monitor our level of commitment and orientation to serving customer needs.
8	MSC08	We freely communicate information about our successful and unsuccessful customer experiences across all business functions.
9	MSC09	Our strategy for competitive advantage is based on our understanding of customers' needs.
10	MSC10	We are more customer-focused than our competitors.
11	MSC11	Data on customer satisfaction are disseminated at all levels in this business unit on a regular basis.
12	MSC12	Our salespeople share information with each other about competitors.
13	MSC13	We respond rapidly to the competitive actions of our rivals.
14	MSC14	Top managers from each of our business units regularly visit customers.
15	MSC15	Business functions within our organization are integrated to serve the target market needs.
16	MSC16	Top management regularly discusses competitors' strengths and weaknesses.
17	MSC17	We share resources among business units.

3.9.2 Measurement Scale for Product Innovation Performance (PIP)

Given the nature of the inquiry of the present work, a special focus was directed at new product performance of the firms as it was influenced by technology-scanning capability and market-scanning capability of firms. Cooper and Kleinschmidt (1995) used a scale to measure the new product performance of firms when they reported their findings in benchmarking the firms' critical success factors in new product development. More recently, Alegre et al. (2006) reported a measurement scale of product innovation performance where they modeled it as a two-dimensional construct. The 'efficacy' component of their scale was similar to the assessment tool provided in Oslo Manual (OECD-EUROSTAT 1997) for economic innovation efficacy that reflected the degree of success of an innovation. The other component in their scale, called 'efficiency', reflected the effort carried out to achieve the degree of success captured by the efficacy component – it captured the cost and time of the innovation. Wheelwright and Clark (1992) supported the use of these two as a measure of product innovation efficiency. Several other studies (Griffin 1993; Griffin and Page 1993; Pisano 1994; Griffin 1997; Hoopes and Postrel 1999; Zhang and Doll 2001; McEvily and Chakravarthy 2002; Valle and Avella 2003) had also considered cost and development time for their work in innovation efficiency, both as an objective measure and as a subjective measure. Table 3-6 shows the individual scale items that was generated based on the items in Alegre et al. (2006) scale and these were used during survey administration. These items were used for further exploratory analysis before using it in the overall research model.

Table 3-6 Product Innovation Performance (PIP) Scale Items

#	Item Codes	Items
1	PIP01	Our company successfully replaces the products that are being phased out.
2	PIP02	Our company extends its core product offering through technologically new products.
3	PIP03	Our company extends its core product offering through technologically improved products.
4	PIP04	Our company often extends its product range outside the core product offering.
5	PIP05	Our company develops environment-friendly products.
6	PIP06	Market share of our products is improving.
7	PIP07	Our company often breaks into new overseas market.
8	PIP08	Our company often captures new domestic market segments.
9	PIP09	Our company takes less time to develop a new product or a new component in comparison with our major competitors.
10	PIP10	Average cost to develop a new product or a new component is less for our company in comparison with our major competitors.
11	PIP11	Overall satisfaction of top management with the efficiency of new product development is very high.

3.9.3 Measurement Scale for Overall Firm Performance (OFP)

Measuring performance is an issue with many challenges and debates. Researchers have used a wide variety of methods and constructs to measure firm-level performance. Jaworski and Kohli (1993) used a subjective measure of overall performance, while Han et al. (1998) used objective measures (e.g., net income growth, return on asset). Han et al. also used business performance measures on growth and profitability. Following Jaworski and Kohli's lead, Olson et al. (2005) subjectively measured overall firm performance, but they used a slightly different scale than used by the earlier authors. Olson et al.'s (2005) scale to measure overall firm performance was used for the current study; Table 3-7 shows the individual scale items used in the survey instrument.

Table 3-7 Overall Firm Performance (OFP) Scale Items

#	Item Codes	Item
1	OFP01	The overall performance of our company met expectations last year.
2	OFP02	The overall performance of our company last year exceeded that of our major competitors.
3	OFP03	Top management was very satisfied with the overall performance of our company last year.

3.9.4 Measurement Scale for Market Turbulence (MktTurb)

Olson et al. (2005) used the market turbulence construct as a control variable to examine the relationship between market variables and overall business performance. Alternately, Narver et al. (2004) tested the influence of market turbulence on new product success. Similarly, the market turbulence construct had been used by the researchers to capture the aspects of the environmental volatility that related to the customers' changing preferences. The level of heterogeneity in the demand was captured using this construct. Jaworski and Kohli (1993) used a six element scale to measure Market Turbulence. Later, variations of this scale were used by Narver et al. (2004) and Olson et al. (2005). The scale from Narver et al. (2004), which had four items, was used for the current study, and is shown in Table 3-8.

Table 3-8 Market Turbulence (MktTurb) Scale Items

#	Item Codes	Items
1	MT01	In this market, customers' preferences change quite a bit over time.
2	MT02	Customers in this market are very receptive to new-product ideas.
3	MT03	New customers tend to have product-related needs that are different from those of existing customers.
4	MT04	We cater to much the same customer base that we did in the past. (R)

3.9.5 Measurement Scale for Technology Turbulence (TechTurb)

Firms are more inclined to focus on technology landscape when the turbulence in technology field is perceived to be high. Hence, the technology turbulence construct was considered in the research model for this study as the moderating variable. Narver et al. (2004) examined the influence of technology turbulence as a moderating variable in the relationship between market orientation and new product success. When technology turbulence is high, firms have more opportunity, but also more threat, from the technology field. March (1991) suggested that depending on the strategic posture, a firm can focus on exploitation of current knowledge to develop new products, or the firm can choose to explore new information in order to develop new products. Successful execution of exploitation or exploration strategies depends on the availability of complete information from the technology domain. Given the dynamic characteristics of technologies compared with other domains that affect the firm's strategy making, knowing the current status of technology and future trajectory of it is essential for making correct decisions that would influence business performance. Olson et al. (2005) used technology turbulence as control variable to examine the relationship between market variables and overall business performance. The scale to measure technology turbulence as used by Olson et al. is shown in Table 3-9; it was used for the current study.

Table 3-9 Technology Turbulence (TechTurb) Scale Items

#	Item Codes	Items
1	TT01	The technological sophistication of products in this industry is changing rapidly.
2	TT02	Technological change provides big opportunities in our industry.
3	TT03	It is very difficult to forecast where the technology in this market will be in five years Time.
4	TT04	Many new product ideas have been made possible by technological advances in our industry.
5	TT05	Technological developments in our industry are relatively minor. (R)

3.10 Data Collection

The next stage of research was performed with data from a national survey. After reducing the number of items for the technology-scanning capability (TechScan) scale and improving the wording for the actual questionnaire, the survey instrument was developed by adding other questions to measure the remaining latent constructs in the research model. A 64-question-long questionnaire was developed, along with additional demographic questions. The survey instrument was delivered through the web to a national sample of managers of different manufacturing firms. A web-based survey was selected as a methodological option because of the benefits of speed, reasonable cost, and easy accessibility, and because of the geographic dispersion of the target participants (Ilieva et al. 2002; Deutskens et al. 2004; Cole 2005; Evans and Mathur 2005; Wright 2005; Deutskens et al. 2006; Deutskens et al. 2006). The survey instrument is included in Appendix E. When the contact email information of C-level officers (e.g., CEO, CTO) was not available, preference was given to recruit someone from General Management, R&D or Marketing.

The Industry Canada database of Canadian Company Capabilities (CCC 2008) was used to find contact information of Canadian companies who are engaged primarily in manufacturing. A total of 17,272 usable contacts (i.e., email addresses) of firms who listed their primary business activity as ‘Manufacturer / Processor / Producer’ were available at the time in the database. These firms were invited through email to participate in a web-based survey. The contact rate for the survey was 77.3%, while the cooperation rate was 3.1%. With an initial count of responses of 476 cases (which included some missing values), the response rate was 2.8%. A few other contacts attempted to take the survey, but their responses did not include enough data points; therefore these cases were discarded by the Survey Research Centre at the University of Waterloo, who conducted the survey. Although low, this response rate was not unlike responses of other online research surveys conducted within the department. Every effort was made to increase the response rate by development of a user-friendly interface, by careful design of the questionnaire so that the questions were unambiguous, by use of reminders, and by timing of the survey. Also, the service of Survey

Research Centre was used to conduct the survey with the expectation that the reputation of the university would help increase the response rate. The main body of the survey consisted of a list of 7-point Likert scale questions. The survey also asked questions about profiles of the business and about characteristics of the individual respondents within the business. For practical reasons, those cases that had 12 or more missing values (about 20% of 64 values for each case) were deleted. The remaining 467 cases were used for further analysis.

Recently, Rogelberg and Stanton (2007) opined that it was important to look at the variables in questions and examine whether they were logically connected with a sample population. For example, a study to find out the effect of overwork would be problematic since potential respondents would be too busy to participate. They suggested that unless there were such logical connection, the concern for non-response bias might not be as important. Accordingly, their study made a distinction between passive and active non-responders. Active non-responders reject participation for some reason, while the passive non-responders might be just forgetting to participate or might not have time to complete the survey. Because of the nature of the current study, there was no strong reason for prospective participants to reject outright the idea of participation; rather the non-respondents were more likely passive ones who did not have time to complete the survey or might just had been forgetting to participate. Accordingly, no effort was made to characterize the non-responders during the survey administration. As the survey used a reminder to increase the relatively low initial response rate, there was an opportunity to use the respondents who acted on the reminder to proxy for non-responders. Indeed, Creswell (1994) and Armstrong (1977) used such methods. I include an additional discussion in Appendix F to show the effect of such assumptions.

3.11 Common Method Variances in Data Collection and Their Remedies

Measurement errors, which weaken the validity of conclusions made about relationships between constructs, can occur in two ways; they are either random errors or systematic methodological errors (cf. Nunnally 1978; Spector 1987; Bagozzi and Yi 1991). While both of these types of error create problem for the researchers, according to Campbell and Fiske (1959), a systemic component of the measurement errors can seriously confound the empirical result, raising doubts in the conclusions reached about the relationships between constructs. These errors provide a potential rival explanation for the observed relationships (Podsakoff et al. 2003); when strong enough, these could even invalidate the findings of an empirical study. Bagozzi and Yi (1991) stated that one of the main sources of systemic error is method variance that accounts for the errors rising from the measurement method as opposed to being caused by the construct of interest. This method variance could be related to the content of specific items, scale types, response formats, or the general context (Fiske 1982). In addition, these variances could reflect phenomena that are more abstract, such as social desirability, acquiescence or leniency effects (Bagozzi and Yi 1991).

The common method error affects both the measurement of constructs and relationships between the constructs. Among others, Bagozzi and Yi (1990), Cote and

Buckley (1987; 1988) and Williams et al. (1989) analyzed common method variance at the construct level. Fuller et al. (1996), Gerstner and Day (1997), Lowe et al. (1996), Podsakoff et al. (2000) and Wagner and Gooding (1987) examined the influence of the common method variance on the relationships between constructs. Cote and Buckley (1987) found that systemic sources of measurement error (e.g. common method error) might account for 26.3% of the variances in a typical research measure. These variances differed discipline-wise. They found that the common method variance was highest at 30.5% in the field of education, and lowest at 15.8% in the marketing field. The reported reduction in variance in relationships between constructs explained in the literature was approximately 24% (down from 35% to 11%) when common variance was not present.

Systemic method errors originate from a common rater, item characteristics, context of specific items, and measurement context of the items (Podsakoff et al. 2003). For any given study, more than one of these factors are likely in effect. So, there is a need to be aware of the problems that these factors might create and take remedial actions whenever necessary. The potential weaknesses arising from common method variances in the context of the current study and the remedial steps that have been taken to minimize the effect are discussed next. Procedural remedies attempt to reduce the common method bias through design of the study. Tourangeau et al. (2000) suggested that researchers should define terms and concepts unambiguously, using examples when necessary; ask simple questions and avoid double-barreled questions in order to reduce unwanted bias in the responses.

3.12 Procedural Remedies for Common Method Variance

3.12.1 Remedies for Bias Produced by a Common Source or Rater

Podsakoff et al. (2003, p. 881) defined social desirability as “the tendency on the part of individuals to present themselves in a favorable light, regardless of their true feelings about an issue or a topic.” This view arises from people’s need for perceived social acceptance and their belief that such an acceptance can be attained by means of culturally acceptable and appropriate behavior (Crowne and Marlowe 1964). According to Ganster et al. (1983), social desirability may suppress a true relationship, serve as a moderator for a relationship between two other constructs, or, at least, can change the strength of a relationship. Each of the questions in the survey instrument was examined and improved to avoid social desirability bias. Anonymity reduces the common method variances caused by social desirability of the respondents. The design and delivery method of the survey, which was conducted through the web, ensured anonymity, and respondents were aware of the fact that their responses are anonymous.

When respondents let their personal feelings and knowledge influence their rating of a particular item or person, the resulting bias has been defined as *leniency bias* (Guilford 1954; Schriesheim et al. 1979; Farh and Dobbins 1989; Vinton and Wilke 2009). When raters are familiar with the ratee or the researchers who are conducting the survey, the familiarity might influence the responses. Random selections of respondents who are unknown to the researcher and ensuring anonymity of the respondents in a web survey method usually help to avoid this kind of bias. The same approach was used in the present study by selecting respondents who did not have prior knowledge of the researcher.

People in general have a tendency to appear consistent and rational in their responses. This observation is supported by researchers, who suggest that people try to maintain consistency between their cognition and attitudes. When it comes to a survey, this inherent tendency leads people to search for similarities in the questions and make an effort to answer those consistently. This tendency of respondents is called *consistency motif* (Podsakoff and Organ 1986; Johns 1994; Schmitt 1994) or the *consistency effect* (Salancik and Pfeffer 1977). The tendency is particularly problematic when the survey questions ask for retrospective accounts of people's attitudes, perception and behaviors (Podsakoff et al. 2003). As part of research design, changing the order of the questions as they are presented to the respondents would minimize the bias caused by consistency motif. Hence the order of the questions was randomly changed for the current study to achieve this goal.

3.12.2 Remedies for Bias Produced by Item Characteristics

As in the tendency of people to be influenced by social desirability, sometimes it is a property of the items in a construct or a questionnaire that has a similar influence (Thomas and Kilmann 1975; Nederhof 1985). For this phenomenon of *item social desirability*, items with more social desirability could exhibit a stronger as opposed to the same correlation due to the underlying constructs that these were intended to measure. In order to reduce the potential for such bias, it is important to avoid sensitive wordings that might act as a cue for the respondents. The questions were carefully reviewed to avoid such biases for the current study.

The opinion of a respondent about the content of a specific item in a questionnaire is often influenced by the way it is presented. When items are presented in a complex or ambiguous way, the respondents may be prone to develop their own idiosyncratic meaning for them (Podsakoff et al. 2003), thereby creating the possibility of respondents' own biased tendencies (e.g., social desirability, leniency) becoming more pronounced. This complexity of or ambiguity to the item could be introduced by the use of technical jargon or colloquialisms (Spector 1992), double-barreled questions (cf. Hinkin 1995), unfamiliar or infrequently used words (Peterson 2000), or words with multiple meanings (Peterson 2000). Careful consideration of the wording of the questionnaire can reduce this bias, as was done in several steps in the current study.

Scale format and anchors in scale can systematically influence responses in a particular survey (Tourangeau et al. 2000). A common scale format that is used is the Likert scale which uses scale anchors such as 'extremely', 'somewhat', 'always', and 'strongly'. These anchors add convenience to the respondents and may accelerate completion of the survey. It is important for the researchers to be aware of this bias and take necessary remedial action. To test for this bias, the current study added a particular question in two different formats. The respondents were asked to rate the statement "Output of our company is best described as a product" using a 7-point Likert scale. A similar question was included in the demographics section of the survey, which used a multiple-choice format and asked participants to choose from a list of three choices in response to this statement: "Sales of our company come from." A comparison of the responses provides a measure of the bias and is useful for making a judgment on whether any extra caution is needed before reaching conclusions about the study findings in general. The details of the finding of this test are shown in Table 3-10; as can be seen from the table, the respondents tend to choose the neutral position when such an option is explicitly given as a choice by the presentation format. However, the bias is not severe in this case, and can be worked with.

Table 3-10 Comparison of Format of Question

	Using a Likert Scale	Using Multiple Choice Format
Product Majority	353	402
Service Majority	50	28
Equal Weight	60	18

3.12.3 Remedies for Bias Produced by Item Context

Length of scales used in the survey may have an impact on the responses. While shorter scales create less fatigue and minimize carelessness (Hinkin 1995) and improve the quality of responses, they may also increase the possibility that responses will be affected by the questions of previous scales (Harrison et al. 1996). This unwanted outcome may result since respondents are likely to remember their answers of the previous questions and be influenced by them. As a way to deal with this problem, inter-mixing of items of different scales is often used; it is a strategy that has both supporters and critics. For example, Kline, Sulsky et al. (2000) recommended inter-mixing as a way to handle common method variances; however, it might increase inter-construct correlations and decrease intra-construct correlations (Podsakoff et al. 2003) – none of them ideal options. In the current study, the scale lengths vary from 4-item-scale to 17-item-scale. More importantly, the 64 items of the questionnaire were grouped in eight groups containing eight items each, and the groups were randomly ordered while presenting the survey to the respondents. This arrangement inter-mixed items from different constructs should reduce the bias that might had otherwise been present.

3.12.4 Remedies for Bias Produced by Measurement Context

Measurement context may also be responsible for the common method variances. When both independent and dependent variables are measured concurrently, the likelihood of sharing systemic co-variation among them increases (Podsakoff et al. 2003). Measurement context is also influenced by both the location and the medium of the survey. For example, the face-to-face interview method induces more socially desirable responses than computer administered surveys (Martin and Nagao 1989; Richman et al. 1999). Since the current study was administered through the web, with invitations sent through email addresses, it had the advantage of being impersonal, likely affected by less social desirability bias. Moreover, the popularity of broadband internet accessibility would enable a web-based survey to be taken by the respondents in a variety of situations, perhaps reducing some common method variances arising from the single-type of location, like an office environment. Although it was not asked whether the respondents completed the survey in one sitting, it is plausible to expect that some of the respondents answered some of the questions in work environment while completing the remaining questions in a different physical setting.

3.13 Conclusion

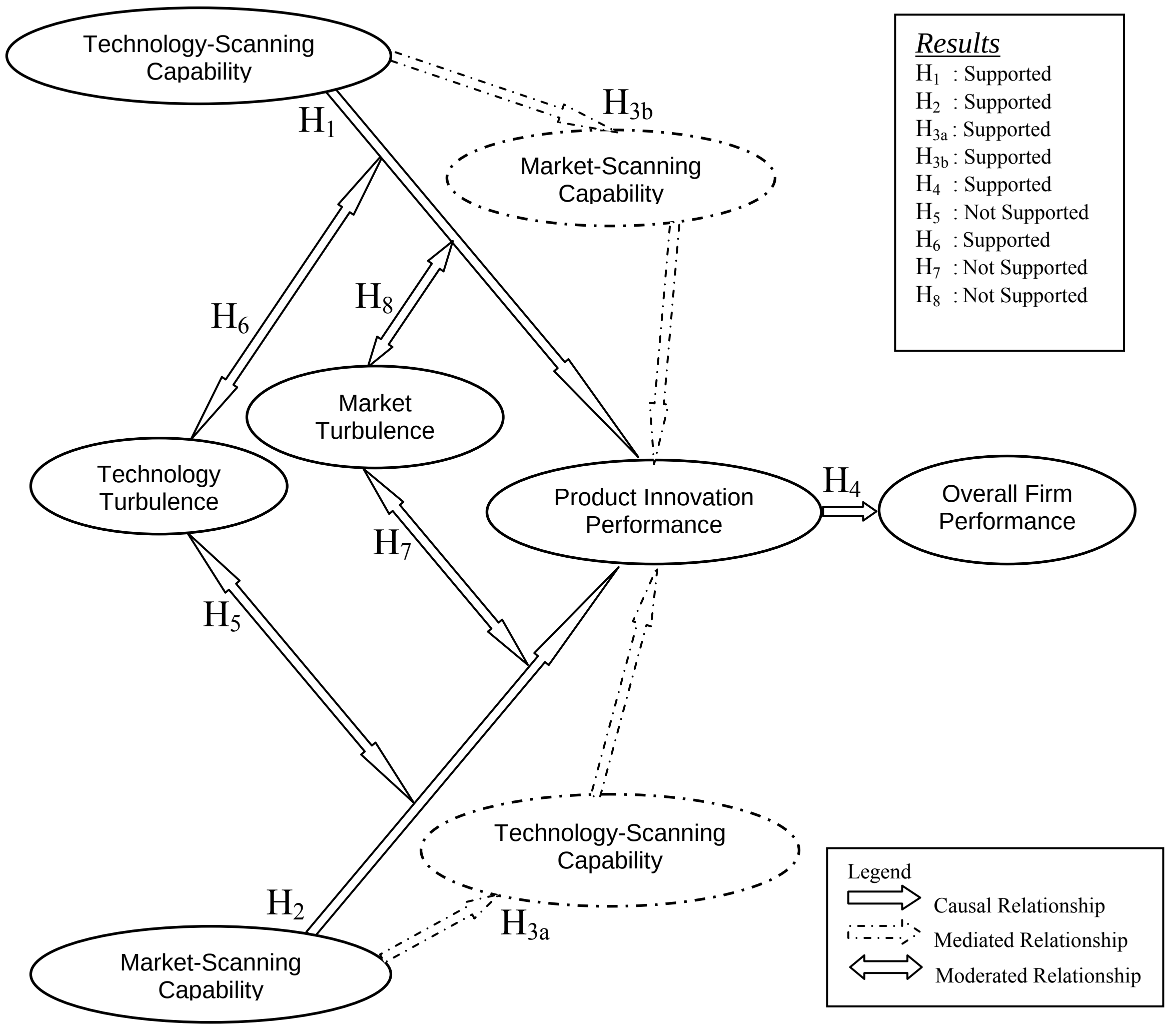
This chapter described the development methodology that has been followed for the study. It first described the qualitative development of the technology-scanning capability scale, and then described all the other scales that were partially or fully adopted from existing literature. The chapter also outlined the national survey used to collect the data. Next, different types of common method variances were described in the context of the current study and corresponding remedies that have been implemented were discussed. The next chapter presents the analysis of data collected through the national survey. The data were used in two stages – first to develop the technology-scanning capability scale and market-scanning capability scale; and then, to validate the overall research model.

Chapter 4
Data Analysis and Findings

4.1 Introduction

The early steps to develop a scale to measure technology-scanning capability (TechScan) were described in Chapter 3. In the first part of this chapter, the items of the TechScan scale were refined and finalized including its underlying factors following guidelines from Churchill (1979), Gerbing and Anderson (1988), DeVellis (2003), Marsh (1985), Spector (1992), and Worthington and Whittaker (2006). In the second part of the chapter, the scale to measure market-scanning capability (MktScan) was examined to establish its underlying factors. Next, the same procedure was repeated for product innovation performance (PIP) to examine its underlying factors. Then, the scales for TechScan, MktScan and PIP were used to validate the core research model. In doing so, how the TechScan and MktScan capabilities influenced performance of the firms was tested. Product innovation performance was used as the dependent variable, which in turn influenced the overall business performance of the firms. Possible mediating effects that either of the scanning capabilities might exhibit in explaining the relationship between the other scanning capability and product innovation performance were also examined. Then, the moderating effects of market turbulence and technology turbulence were examined. Overall research model was shown in Figure 3-2 in previous chapter and the same is repeated in Figure 4-1, this time with results included.

Figure 4-1 Overall Research Model (With Results)



4.2 Developing a Scale to Measure Technology-Scanning Capability (TechScan)

The scale to measure technology-scanning capability was modeled as a reflective construct. Researchers have also suggested an alternate way to model constructs which are formative in nature. Formative indicators are observed variables that cause the latent variable as opposed to being affected by the latent variable as is the case of reflective indicators (1989; Bollen 2002). The direction of causality between indicators and latent constructs are opposite in formative and reflective models (MacCallum and Browne 1993). Formative constructs are driven by theory, and the items that constitute the latent formative constructs are not necessarily correlated (1999). In the formative model, all the items are necessary parts of the constructs, so dropping an indicator may change the conceptual domain of the construct.

Compared with the characteristics mentioned for formative indicators, reflective constructs can be independently modeled without interaction with other constructs (Rossiter 2002). Hence, the results are more generalizable and can be compared across studies. Bollen (2002) explained further to this by saying that reflective constructs are more commonly used by social science researchers. Diamantopoulos and Winklhofer (2001, p. 274) asserted: "The choice between a formative and a reflective specification should primarily be based on theoretical considerations regarding the causal priority between the indicators and the latent variable involved." Considering the theoretical aspects of the construct, a reflective model for the technology-scanning capability (TechScan) was chosen since the indicators of the construct can be interchangeable to some extent and dropping a single indicator should not alter the conceptual domain of the construct. Indicators of the construct are also expected to co-vary. Lastly, since a common nomological net can be found for the construct indicators while considering the individual items, a reflective model seemed appropriate.

Following the guidelines of Churchill (1979, p. 68), first, the 16-item pool of indicators from the previous chapter was examined for the existence of common core. In other words, the individual items were examined to see if they belong to the 'domain of the concept'. Appendix G shows the item-to-total statistics for each of the items. As can be seen from the item-to-total correlation values, all but one item had a value more than 0.30. The other item (TSC16) had an item-to-total correlation of 0.293, while all the items for TechScan scale, including TSC16, are listed in Table 3-4. Moreover, the Cronbach's Alpha reaches its second highest value when this same item is deleted from the indicator list compared with other Cronbach's Alphas when other items are deleted sequentially. The Cronbach's Alpha reaches its maximum value when another item (TSC14), which has an item-to-total correlation of 0.329, is deleted. Because of these reasons, items TSC16 and TSC14 were possible candidates for being dropped from the final list of items for the scale. However, at this point, all the items were retained for further examination. The inter-item correlation matrix is included in Appendix H.

Next, Bartlett's (1950) Test of Sphericity was performed; the corresponding findings (Chi-Square=2692.39, df=120, $p < 0.00$) indicated statistically significant values. However, this test is not sufficient when the sample size is relatively large (Tabachnick and Fidell 2001). Worthington and Whittaker (2006) also suggested that researchers should provide additional evidence of factorability when cases-per-item ratio is higher than 5:1, which was true for the current study. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA) was used as one such additional evidence of factorability. Tabachnick and Fidell (2001) note that a KMO-MSA value of 0.60 or higher was required for factorability. A test for this criterion resulted in a value of 0.887 for the TechScan scale items, which was satisfactory.

4.2.1 Exploratory Factor Analysis (EFA) of TechScan Items

The purpose of factor analysis (FA) is closely aligned with the development of new scale since factor analysis helps researchers to "understand the latent factors or constructs that account for the shared variance among items" (Worthington and Whittaker 2006, p. 818). If FA is chosen to be the method of factor extraction, there are, again, a number of FA techniques available, including principal-axis factoring, maximum likelihood, image factoring, alpha factoring, and un-weighted and generalized least squares. Among these, principle-axis factoring and maximum likelihood are two widely used techniques. While Gerbing and Hamilton (1996) asserted that these two techniques are relatively equally effective in extracting factors, Gorsuch (1997) reminded that occasional problems are more likely with maximum-likelihood than with principle-axis factoring. For the current study, principle-axis factoring was used to extract the underlying factors for the TechScan scale.

Next, the choice of rotation method was considered; typically two types of rotation are used – orthogonal and oblique rotation. When the set of factors underlying a given items-set are assumed to be or known to be uncorrelated, then orthogonal rotation is recommended. When such factors are assumed to be or known to be correlated, oblique rotation is used (Gorsuch 1983; Thompson 2004). For the TechScan scale, the underlying factors were expected to be correlated to some extent, and hence, oblique rotation was preferred. Worthington and Whittaker (2006) further suggested that even if a theoretical understanding might indicate an uncorrelated factor set, data might exhibit correlation, suggesting the use of oblique rotation. Loehlin (1998) further suggested that orthogonal rotation often over-estimated loadings of individual items, even when both types of rotation produce similar factor structures. An over-estimation in loadings, if that occurred, would likely cause retention of items even when that were unnecessary. All these observations lent support for the choice of oblique rotation.

For choosing the number of factors to retain, Kaiser (1958) and Cattell (1966) provided an important guideline. Both of them used Eigenvalues to determine which factors to retain and which ones to drop. Kaiser (1958) suggested that factors with Eigenvalues of less than 1 are potentially unstable, so those should be dropped. On the other hand, Cattell (1966) used relative values of Eigenvalues to perform a Scree-test and estimated the correct number of factors. Gerbing (1988), Tinsley and Tinsley (1987), Floyd and Widaman (1995) and Costello and Osborne (2005) also used Scree-test, sometimes in combination with other procedures. Tabachnick and Fidel (2001) provided a further guideline, saying that factors with less than three items should be considered for dropping. While deciding on this criterion, they asserted that factors with only two items may be retained only if the correlation were more than 0.70.

With the above-mentioned guidelines, a factor analysis was performed using SPSS 16.0 with principal axis factoring and promax rotation that revealed four factors. These four factors of the TechScan construct suggested by the exploratory factor analysis were also conceptually coherent. Indeed, Worthington and Whittaker (2006, p. 822) suggested: "Conceptual interpretability is the definitive factor-retention criterion. In the end, researchers should retain a factor only if they can interpret it in a meaningful way no matter how solid the evidence is for its retention based on the empirical criteria. EFA is ultimately a combination of empirical and subjective approaches to data analysis because the job is not complete until the solution makes sense." One of these four factors, however, did not pass the strict criteria set forth by Tabachnick and Fidel (2001), since the correlation between two items of a two-item factor is less than 0.70. Three of the items were deleted from the scale as the item either did not load with any of the factors with loading of 0.32 (e.g., TSC10 and TSC16) or it loaded onto more than one factors with cross-loading less than 0.15 difference from an item's highest factor loading (e.g., TSC6) making it difficult to include the item in either factors (Worthington and Whittaker 2006). The corresponding Cronbach's Alphas of these four factors were at an acceptable level. The thirteen-item Cronbach's Alpha was found to be at 0.866. Table 4-1 shows the detailed grouping of the items and corresponding loadings of TechScan scale. Next, Table 4-2 shows the factor correlation matrix of the TechScan scale. Following is a discussion on the naming of the four retained factors for TechScan scale.

Factor 1: TechInfo (Technological Information Gathering)

Six items were included in the first factor. The items correlated strongly, and they had a Cronbach's Alpha of 0.809. These items had a common conceptual thread among them that was related to the information-gathering of technological field. Some of the items were directly concerned with different types of information sources; others were more policy-level characteristics and features of the firms that enabled them to gather technological information effectively. This 6-item factor explained 35.23% of the variance, and was the strongest of the four factors in terms of contribution to the formation of the TechScan scale.

Table 4-1 Factor Analysis of TechScan Scale Items (N=467, α=0.866)

Items	**Item Loadings**	**Factor Names and Corresponding Cronbach's Alpha, % Variance Explained and Eigenvalues**
TSC01: The market drives our search for new technological solutions.	0.346	Factor 1: TechInfo Cronbach's Alpha = 0.809 Eigenvalue: 6.105 % Variance Explained = 35.233
TSC02: Technology plays an important role in our approach to tackling an issue, when appropriate.	0.644	
TSC03: Encourages employees to explore new technological ideas voluntarily.	0.903	
TSC04: Policies, processes and tools to enable employees to explore new technologies.	0.878	
TSC05: Uses the information available within the organization.	0.508	
TSC07: Gathers information from global sources when searching for new technological solutions.	0.440	
TSC11: Makes an attempt to co-develop future development plans about its technology with other players in business network.	0.406	Factor 2: TechAlign Cronbach's Alpha = 0.708 Eigenvalue = 1.212 % Variance Explained = 4.589
TSC12: Looks for synergy of product offerings with existing technological trends in the market.	0.759	
TSC13: Seeks to ensure compatibility with existing technologies, resources and competencies.	0.749	
TSC08: Responds well to any technology information that has a strategic implication.	0.763	Factor 3: TechRespond Cronbach's Alpha = 0.854 Eigenvalue = 1.079 % Variance Explained = 3.963
TSC09: Responds well to any technology information that has an operational implication.	0.982	
TSC14: Seeks to exploit new international markets through acquisition and sale of intellectual property.	0.737	Factor 4: TechExploit Cronbach's Alpha = 0.586 Eigenvalue = 1.006 % Variance Explained = 3.362
TSC15: Engages in both types of innovation, namely, incremental and breakthrough innovation.	0.519	
TSC6 : Uses information from organizations in external network when searching for new technological solutions	This item was dropped since the cross-loading less than .15 difference from item's highest factor loading	
TSC10: Employees from different functional areas usually agree on technology development path.	This item was dropped due to insignificant loadings in all of the factors	
TSC16: Gives specific attention to achieve cost reduction in existing products.	This item was dropped due to insignificant loadings in all of the factors	

Factor 2: TechAlign (Technology Alignment)

Three items formed the second factor of the TechScan scale, and they together explained 4.589% of the variance. The Cronbach's Alpha of this 3-item factor is 0.708. The common conceptual theme among these items was alignment in technological development. Firms were concerned with this issue of alignment in different contexts – alignment with technology trend in the market, compatibility with existing technological competences that existed within the firm and keeping alignment in the technological developments that were occurring within the business network of the firm (e.g., making sure that the supply chain stakeholders were not taken by surprise). Indeed, these alignment pressures often opposed one another, yet firms needed to keep the right balance in order to achieve their business goals.

Table 4-2 Factor Correlation Matrix of TechScan Scale

Factor	**TechInfo**	**TechAlign**	**TechRespond**	**TechExploit**
TechInfo	1.000			
TechAlign	0.627	1.000		
TechRespond	0.655	0.612	1.000	
TechExploit	0.551	0.524	0.518	1.000

Factor 3: TechRespond (Responsiveness to Collected Technology Information)

The third factor was concerned with the responsiveness aspect of the firm's technological activity – it covered response of firms to both internal and external developments. Two items were included in this factor, with a Cronbach's Alpha of 0.854. Combined, these two items explained 3.963% of the variances. Technological developments had their implications for firms' strategy and operations, and firms had to respond timely to technology-related information that had either strategic or operational implications. Together, these two items captured the responsiveness aspect of technological information gathering within the firm.

Factor 4: TechExploit (Exploitation of Technology)

The fourth factor was concerned with the exploitation of existing technologies for which the firm had a direct or indirect access. This 2-items factor explained 3.362% of the variance in TechScan scale and the Cronbach's Alpha of this factor was 0.586. Given the increasing global nature of competitions, firms look at new international markets to access new technologies as well as to license their existing technology portfolio. Also, firms would use their existing resources for both incremental innovation projects and breakthrough innovation projects as these different types had differing implication for the firms overall operation. Incremental innovation would increase the likelihood of maximum exploitation of the current technology portfolio and increase short-term profitability and cash-flow. Breakthrough innovations, on the other hand, increased the likelihood of firms' long-term viability. Given that this factor had only two items, it is subject to correlation criteria set forth by Tabachnick and Fidel (2001) for such factors. Although the correlation is not greater than 0.7, the factor is retained for its conceptual importance of current day practices in firms and for its comparable share of variance with two other factors (TechAlign and TechRespond) that are also retained.

4.3 A Scale to Measure Market-Scanning Capability (MktScan)

Following similar procedure as in the case of technology-scanning capability, the seventeen items for market-scanning capability listed in Table 3-5 were used in exploratory factor analysis with principle axis factoring extraction method and promax rotation. Four underlying factors were found which were also conceptually coherent and these four factors were CustInfo, CmpInfo, MktResp and Coord. One of the items was dropped since the cross-loading less than 0.15 difference from item's highest factor loading. Hence, the MktScan scale now has sixteen items and a Cronbach's Alpha of 0.875. Table 4-3 shows the details of the factors, their item loadings and Cronbach's Alpha of the scale factors. Table 4-4 shows the factor correlation matrix for MktScan scale. Following is a discussion on the naming of the four retained factors of market-scanning capability.

Factor 1: CustInfo (Collection of Information about Customers)

With six items, CustInfo factor measured firm's inclination to proactively understand its customers' present and future needs. Among the items, they measured the extent to which firms used lead users to understand customer needs better, the extent to which firms had internal brainstorming to absorb and understand their current customers, the extent to which firms tried to extrapolate the available data to understand the nature of changes that might happen in the future and to the extent firms tried to find out about their customers' unexpressed needs. These six items correlated strongly with Cronbach's Alpha of 0.843. This factor alone explained 32.166% of the variance of the MktScan scale.

Table 4-3 Factor Analysis of MktScan Scale Items (N=467, α=0.875)

Items	Item Loadings	Factor Names and Corresponding Cronbach's Alpha, Eigenvalues and % of Variance Explained
MSC1: We help our customers anticipate developments in their markets.	0.590	Factor 1: CustInfo Cronbach's Alpha = 0.843 Eigenvalue = 5.998 % of Variance Explained = 32.166
MSC2: We continuously try to discover additional needs of our customers of which they are unaware.	0.670	
MSC3: We brainstorm on how customers use our products and services.	0.550	
MSC4: We search for opportunities in areas where customers have a difficult time expressing their needs.	0.702	
MSC5: We work closely with lead users who try to recognize customer needs months or even years before the majority of the market may recognize them.	0.873	
MSC6: We extrapolate key trends to gain insight into what users in a current market will need in the future.	0.663	
MSC7: We constantly monitor our level of commitment and orientation to serving customer needs.	0.607	Factor 2: CmpInfo Cronbach's Alpha = 0.739 Eigenvalue = 1.923 % of Variance Explained = 8.264
MSC9: Our strategy for competitive advantage is based on our understanding of customers' needs.	0.544	
MSC10: We are more customer-focused than our competitors.	0.704	
MSC13: We respond rapidly to the competitive actions of our rivals.	0.485	Factor 3: MktResp Cronbach's Alpha = 0.676 Eigenvalue = 1.049 % of Variance Explained = 2.939
MSC14: Top managers from each of our business units regularly visit customers.	0.553	
MSC15: Business functions within our organization are integrated to serve the target market needs.	0.633	
MSC8: We freely communicate information about our successful and unsuccessful customer experiences across all business functions.	0.549	Factor 4: Coord Cronbach's Alpha = 0.708 Eigenvalue = 1.013 % of Variance Explained = 2.637
MSC12: Our salespeople share information with each other about competitors.	0.574	
MSC16: Top management regularly discusses competitors' strengths and weaknesses.	0.461	
MSC17: We share resources among business units.	0.618	
MSC11: Data on customer satisfaction are disseminated at all levels in this business unit on a regular basis.	This item was dropped since the cross-loading less than .15 difference from item's highest factor loading	

Factor 2: CmpInfo (Competitiveness)

The CmpInfo factor explained 8.264% of the variance of MktScan scale. Cronbach's Alpha of this 3-items factor was 0.739. It encapsulated the competitiveness aspect of the firms' market information collection and processing activities.

Table 4-4 Factor Correlation Matrix of MktScan Scale

Factors	**CustInfo**	**CmpInfo**	**MktResp**	**Coord**
CustInfo	1			
CmpInfo	0.413	1		
MktResp	0.476	0.600	1	
Coord	0.579	0.548	0.585	1

Factor 3: MktResp (Responsiveness to Collected Market Information)

MktResp was a 3-items factor that measured the responsiveness of firms to the market information that they collected. This factor explained 2.939% of the variance of overall scale of MktScan and the Cronbach's Alpha of the factor was 0.676.

Factor 4: Coord (Coordination among Different Business Units of the Firm)

This 4-items factor measured coordination aspect of firms' market information collection and it explained 2.637% of the variance of MktScan scale. Coordination within firms was reflected in sharing resources among business units, sharing of information and customer experiences among business units and involvement of top management in identifying important issues. The Cronbach's Alpha of the factor was 0.708.

4.4 A Scale to Measure Product Innovation Performance (PIP)

As in case of technology-scanning capability and market-scanning capability, items in product innovation performance scale shown in Table 3-6 were used to run an exploratory factor analysis using principle axis factoring extraction method and promax rotation. Although these items were taken from a single reported scale developed by Alegre et al. (2006) who found two underlying factors (which were called as 'Efficacy' and 'Efficiency' by the original authors), the current exploratory factor analysis revealed three factors. Essentially, the efficacy factor that contained 8 items in the original scale had split into two factors that were named as 'PrdEfficacy' and 'MktEfficacy'. The 'Efficiency' factor remained the same as was originally reported. The 11-items scale for product innovation performance had a combined Cronbach's Alpha of 0.775. Table 4-5 shows further details of each underlying factors of product innovation performance scale and their corresponding item loadings. Table 4-6 shows the factor correlation matrix for product innovation performance scale.

Table 4-5 Factor Analysis of PIP Scale Items (N=467, α=0.775)

Items	**Item Loadings**	**Factor Names and Corresponding Cronbach's Alpha, Eigenvalues and % of Variance Explained**
PIP1 : Our company successfully replaces the products that are being phased out.	.401	Factor 1: PrdEfficacy Cronbach's Alpha = 0.716 Eigenvalue = 3.590 % of Variance Explained = 28.263
PIP2 : Our company extends its core product offering through technologically new products.	.955	
PIP3 : Our company extends its core product offering through technologically improved products.	.835	
PIP4 : Our company often extends its product range outside the core product offering.	.305	
PIP9 : Our company takes less time to develop a new product or a new component in comparison with our major competitors.	.784	Factor 2: Efficiency Cronbach's Alpha = 0.759 Eigenvalue = 1.445 % of Variance Explained = 9.602
PIP10 : Average cost to develop a new product or a new component is less for our company in comparison with our major competitors.	.749	
PIP11 : Overall satisfaction of top management with the efficiency of new product development is very high.	.570	
PIP5 : Our company develops environment-friendly products.	.396	Factor 3: MktEfficacy Cronbach's Alpha = 0.593 Eigenvalue = 1.213 % of Variance Explained =5.734
PIP6 : Market share of our products is improving.	.712	
PIP7 : Our company often breaks into new overseas market.	.398	
PIP8 : Our company often captures new domestic market segments.	.579	

The first factor was a 4-items factor that explained 28.263% of variances in Product Innovation Performance and the corresponding Cronbach's Alpha of the factor was 0.716. This factor encapsulated the effectiveness of the products offered by the firm and named as Product Efficacy (PrdEfficacy). The second factor was named as 'Efficiency' and it was a 3-items factor that encapsulated the efficiency of the firms operations both in time and cost dimensions. This factor explained 9.602% of the variances of the overall scale and the corresponding Cronbach's Alpha for this factor was 0.759. The third factor of the Product Innovation Performance was a four item factor that encapsulated the market efficacy of the firm operations and it explained 5.734% of the variances and it had a Cronbach's Alpha of 0.593. It was named as Market Efficacy (MktEfficacy).

Table 4-6 Factor Correlation Matrix for PIP Scale

Factors	PrdEfficacy	Efficiency	MktEfficacy
PrdEfficacy	1		
Efficiency	0.350	1	
MktEfficacy	0.490	0.472	1

4.5 Scales for Other Constructs of the Model (OFP, TechTurb and MktTurb)

Unlike the three constructs discussed above which were modeled as 2nd order constructs, the remaining three constructs used in the model were originally used as 1st order constructs. Using the collected data, all three constructs – Overall Firm Performance (OFP), Technology Turbulence (TechTurb) and Market Turbulence (MktTurb) – were reaffirmed as 1st order constructs.

Table 4-7 shows the corresponding three items in OFP explained 70.565% of variances with a Cronbach's Alpha of 0.868. Five items in TechTurb constructs explained 54.603% variances with a Cronbach's Alpha of 0.846. One of the items of MktTurb loaded onto the construct with only 0.195 which was much less than the minimum loading of 0.32

suggested for statistical soundness (Worthington and Whittaker 2006). After deleting the item, the remaining three items explained 31.533% of the variances of the MktTurb construct and the corresponding Cronbach's Alpha was 0.564.

Table 4-7 Factor Analysis of 1st Order Scales Used in Research Model (N=467)

Items	**Item Loadings**	**Factor Names, Cronbach's Alpha and % of Variance Explained**
OFP1 : The overall performance of our company met expectations last year.	0.895	Factor Name: OFP Cronbach's Alpha : 0.868 % of Variance Explained: 70.565*
OFP2: The overall performance of our company last year exceeded that of our major competitors	0.660	
OFP3: Top management was very satisfied with the overall performance of our company last year.	0.938	
TT1: Our company operates in an industry in which the technological sophistication of products is changing rapidly.	0.852	Factor Name: TechTurb Cronbach's Alpha = 0.846 % of Variance Explained = 54.603*
TT2: Technological change provides big opportunities in our industry.	0.782	
TT3: It is very difficult to forecast where the technology in this market will be in five years time.	0.485	
TT4: Many new product ideas have been made possible by technological advances in our industry.	0.811	
TT5 (R): Technological developments in our industry are relatively minor.	0.707	
MT1: In this market, customers' preferences change quite a bit over time.	0.657	Factor Name: MktTurb Cronbach's Alpha = 0.564 % of Variance Explained = 31.533*
MT2: Customers in this market are very receptive to new-product ideas.	0.569	
MT3: New customers tend to have product-related needs that are different from those of existing customers.	0.435	
MT4 (R): We cater to much the same customer base that we did in the past.	This item was dropped since the loading was much less than the 0.32 (0.195).	

* Variance explained of these three different scales should not be added together.

4.6 Reliability and Validity of the Constructs

The basic research model consisted of four firm-level constructs – technology-scanning capability, market-scanning capability, product innovation performance and overall firm performance. All four constructs were modeled as reflective – the first three were second-order reflective constructs (i.e., TechScan, MktScan and PIP) and the fourth was a first-order reflective construct (i.e., OFP). According to Nunnally (1978), in order for factors to be considered as having convergent validity and reliability, both of Cronbach's Alpha and Construct (Composite) Reliability scores have to be 0.7 or greater. Fornell and Larcker (1981) further provided guidelines by specifying the measure of Average Variance Extracted (AVE) value of greater than 0.5 in order for the measurement error associated with the construct to be outweighed by the variance extracted through its indicators. The corresponding factor loading, AVE, Cronbach's Alpha and Composite Reliability value are shown in Table 4-8.

Gefen et al. (2000) provided guidelines for examining the discriminant validity at the construct-level and indicator-level. The square root of AVE was compared with cross-correlation of the constructs. If all of the cross-correlations of the constructs were less than the square root value of the AVE, then the condition for construct-level discriminant validity would be fulfilled. Further, in order for the items and the components to be internally reliable and to have discriminant validity, component-level and item-level cross-loadings for each item should load more highly on its assigned construct than on the other constructs. Table 4-9 and Table 4-10 show the results, which were satisfactory.

Table 4-8 Details of the Constructs' Internal Consistency, Convergent Validity

Constructs and their factors, if the construct is second order	**Order of the Construct and Alpha of Components, if 2nd Order**	**Cronbach's Alpha of the construct**	**AVE**	**Composite Reliability**
TechScan	**2nd Order**	**0.866**	**0.597**	**0.855**
TechInfo	.809		0.516	0.861
TechAlign	.708		0.642	0.842
TechRespond	.854		0.865	0.928
TechExploit	.586		0.688	0.813
MktScan	**2nd Order**	**0.875**	**0.608**	**0.861**
CustInfo	.843		0.553	0.881
CmpInfo	.739		0.651	0.848
MktResp	.676		0.616	0.828
Coord	.708		0.534	0.821
Product Innovation Performance	**2nd Order**	**0.775**	**0.562**	**0.793**
PrdEfficacy	.716		0.568	0.836
Efficiency	.759		0.664	0.855
MktEfficacy	.593		0.465	0.773
Overall Firm Performance (OFP)	**1st Order**	**0.868**	**0.792**	**0.919**
Technology Turbulence (TechTurb)	**1st Order**	**0.846**	**0.621**	**0.888**
Market Turbulence (MktTurb)	**1st Order**	**0.564**	**0.398**	**0.703**

Table 4-9 Discriminant Validity of Constructs

	MktScan	MktTrub	OFP	PIP	TechTurb	TechScan
MktScan	**0.779***					
MktTurb	0.241	**0.631**				
OFP	0.368	0.133	**0.890**			
PIP	0.609	0.308	0.425	**0.749**		
TechTurb	0.251	0.364	0.149	0.359	**0.788**	
TechScan	0.664	0.316	0.265	0.629	0.491	**0.773**

* Square Root of AVE where AVE is generated by aggregating first-order factors, if applicable.

Table 4-10 Indicator Cross Loadings Showing Reliability and Discriminant Validity

	MktScan	PIP	TechScan
CmpInfo	**0.776**	0.443	0.471
Coord	**0.734**	0.416	0.450
CustInfo	**0.819**	0.546	0.589
MktResp	**0.782**	0.455	0.520
Efficiency	0.398	**0.710**	0.392
MktEfficacy	0.451	**0.729**	0.427
PrdEfficacy	0.517	**0.817**	0.577
TechAlign	0.549	0.473	**0.767**
TechExploit	0.414	0.549	**0.662**
TechInfo	0.576	0.501	**0.891**
TechRespond	0.517	0.514	**0.775**

4.7 Influence of TechScan and MktScan on PIP

Next, the influences of market-scanning capability (MktScan) and technology-scanning capability (TechScan) of a firm on its performance were examined. Two-stage measures of performance were used and they were: product innovation performance (PIP) and overall firm performance (OFP). The two-stage representation helped to isolate the final business performance from market-scanning capability and technology-scanning capability, since a number of other factors also influence the final business outcome. Product innovation performance was used to examine the direct influence of MktScan and TechScan in the first stage. Then, the influence of PIP on OFP was determined.

In order to explore the influence of MktScan and TechScan capabilities on PIP as it was manifested in the current set of data, Pearson correlations between MktScan-PIP and TechScan-PIP was derived. Both of these coefficients, as shown in Table 4-11, were found to be statistically significant – thereby supporting the hypotheses H_1 and H_2.

Table 4-11 Pearson Coefficients to Test Hypotheses H_1 and H_2

Hypotheses			PIP
H_1	TechScan	Pearson Correlation	0.645
		Sig. (2-tailed)	0.000*
		N	409
H_2	MktScan	Pearson Correlation	0.571
		Sig. (2-tailed)	0.000*
		N	393

*Correlation is significant at the 0.01 level (2-tailed).

4.8 Mediation Effects of TechScan and MktScan Capabilities

Hypotheses H_1 and H_2 indicated that both TechScan and MktScan capabilities of firms played an important role on their innovation performance. These influences were not always independent of each other. Using the sense-and-respond framework as a tool for analysis, firms' TechScan and MktScan capabilities might be used to either sense the weak signals in their business environment or respond to the already sensed weak signals. In many cases, this sense-and-respond cycle could start randomly either in market domain or in technology domain. In other cases, the sense-and-respond cycle might have a tendency to start in a specific domain. Depending on the focal industry of the firm or the culture within the firm, it might emphasize technology-scanning capability more than market-scanning capability. Such a tendency would lead the firm to identify useful information more in the technology domain than the market domain and then use those technological advantages into new or improved products and services. These characteristics would make these firms resemble technology-push firms. On the contrary, market-pull firms would have a tendency to emphasize market-scanning capability over technology-scanning capability. In this second category, firms are more likely to sense the weak signals in the market domain and respond to those signals with information collected in technology domain.

To further examine the interaction among market-scanning capability, technology-scanning capability and product innovation performance, it was examined whether TechScan capability mediated the relationship between MktScan and PIP in Hypothesis H_{3a}. Firms with a market-scanning capability higher than their technology-scanning capability were expected to exhibit this phenomenon more; compared to firms with a market-scanning capability lower than their technology-scanning capability. Table 4-12 shows the relevant measures of the tests for Hypothesis H_{3a}. A measure of the ratio of Indirect to Total Standardized Coefficients between MktScan and PIP showed that the mediation effect was highest when MktScan > TechScan with the ratio 0.503.

Table 4-12 Mediating Role of TechScan (Hypothesis H_{3a})*

	Full Dataset (N = 467)	MktScan > TechScan (N = 257)	MktScan < TechScan (N = 123)
Hypothesis	H_{3a}	H_{3a}	H_{3a}
Independent Variable	MktScan	MktScan	MktScan
Outcome Variable	PIP	PIP	PIP
Mediating Variable	TechScan	TechScan	TechScan
Standardized Coefficient between MktScan and PIP (Total)	0.571	0.535	0.765
Standardized Coefficient between MktScan and PIP (Direct)	0.291	0.266	0.495
Standardized Coefficient between MktScan and PIP (Indirect)	0.280	0.269	0.270
Type of Mediation	Partial	Partial	Partial
Ratio of Indirect and Total Standardized Coefficients Between MktScan and PIP	0.490	0.503	0.353

* Mediation analysis performed using MedGraph (Jose 2003).

Similarly, it was also examined whether MktScan capability mediated the TechScan-PIP relationship when firms had a higher measure of technology-scanning capability compared to their market-scanning capability. This was captured in Hypothesis H_{3b}. Table 4-13 shows the relevant measures of the tests for Hypothesis H_{3b} and the hypothesis was found to have empirical support. A measure of the ratio of Indirect to Total Standardized Coefficients between TechScan and PIP showed that the mediation effect was highest when TechScan > MktScan with the ratio 0.607.

Table 4-13 Mediating Role of MktScan (Hypothesis H_{3b})*

	Full Dataset (N = 467)	TechScan > MktScan (N= 123)	TechScan < MktScan (N = 257)
Hypothesis	H_{3b}	H_{3b}	H_{3b}
Independent Variable	TechScan	TechScan	TechScan
Outcome Variable	PIP	PIP	PIP
Mediating Variable	MktScan	MktScan	MktScan
Standardized Coefficient between TechScan and PIP (Total)	0.645	0.749	0.565
Standardized Coefficient between TechScan and PIP (Direct)	0.454	0.294	0.373
Standardized Coefficient between TechScan and PIP (Indirect)	0.191	0.455	0.192
Type of Mediation	Partial	Partial	Partial
Ratio of Indirect and Total Standardized Coefficients Between MktScan and PIP	0.296	0.607	0.339

* Mediation analysis performed using MedGraph (Jose 2003).

4.9 Relationship between PIP and OFP

In this study, performance was the outcome variable that was conceptually modeled to be influenced by market-scanning capability and technology-scanning capability. Since, overall business performance of a firm depended on a number of variables not under consideration for this study; a two-stage approach to measure performance of the firm was used. As discussed above, product innovation performance (PIP) was considered to be directly influenced by the scanning capabilities. On the next stage, overall firm performance (OFP) was driven by PIP. Table 4-14 shows that the Pearson correlation coefficient was statistically significant between PIP and OFP measures for the current set of data and hence, Hypothesis H_4 was supported.

Table 4-14 Pearson Coefficient to Test Hypothesis H_4

Hypothesis			OFP
H_4	PIP	Pearson Correlation	0.394
		Sig. (2-tailed)	0.000*
		N	421

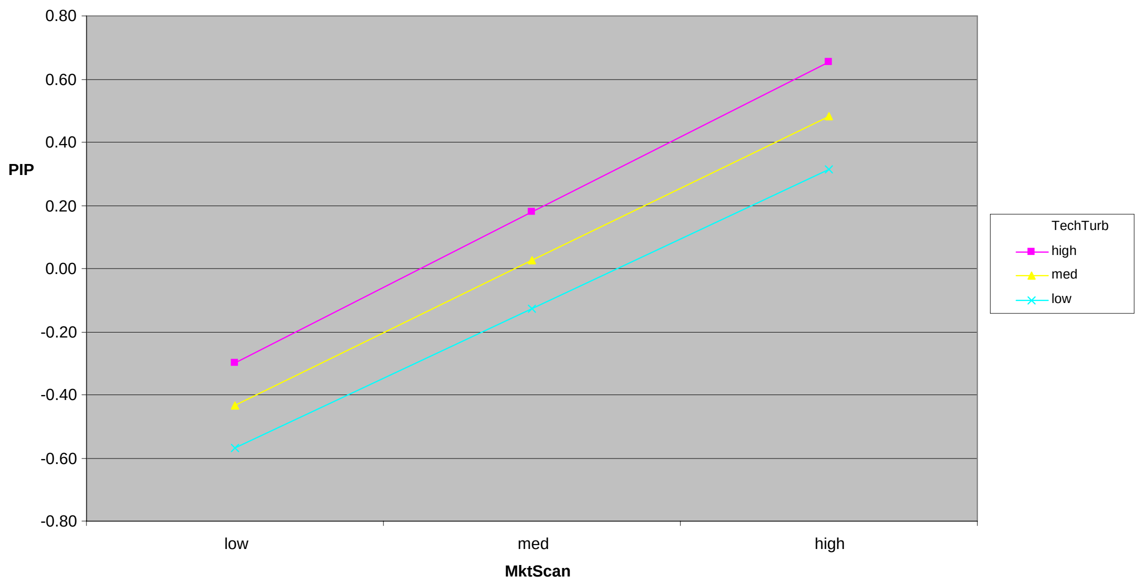
*Correlation is significant at the 0.01 level (2-tailed).

4.10 Moderating Effect of Environmental Turbulences

It was intuitive that the relationships among market-scanning capability, technology-scanning capability and product innovation performance would be influenced by the turbulences that existed in the business environment. An examination of the moderating effects of environmental turbulence would add value to the insights acquired so far from the data analysis. Two different measures of environmental turbulence, namely market turbulence and technology turbulence, were used. Hypotheses H_5, H_6, H_7 and H_8 used these two turbulence measures to measure their influences on product innovation performance.

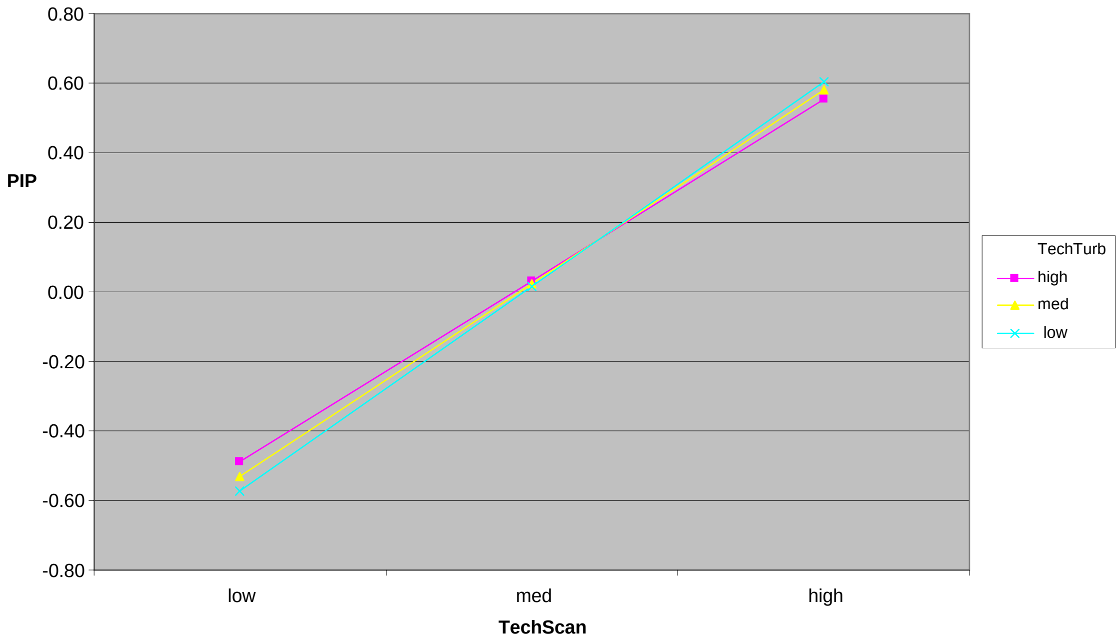
Figure 4-2 through Figure 4-5 graphically show the result of the test for moderation effects of technology turbulence and market turbulence on the relationships between MktScan and product innovation performance and between TechScan and product innovation performance. The moderation analysis was performed using ModGraph (Jose 2008). From these figures, it was evident only in Figure 4-3 that the moderating effect of technology turbulence (TechTurb) on the relationship between technology-scanning capability (TechScan) and product innovation performance (PIP) was significant. Other moderating effects as shown in Figure 4-2, Figure 4-4 and Figure 4-5 were not significant. Hence, out of the four hypotheses (Hypotheses H_5, H_6, H_7 and H_8) that deal with moderating effects of different types of environmental turbulences, only Hypothesis H_6 was supported.

Figure 4-2 Moderating Effect of TechTurb on MktScan-PIP Relationship



It should be recognized that there is a fundamental difference between the two types of environmental turbulences considered here. Increased value of market turbulence often could be a result of multiplying effect of similar change (e.g., number of competitors changed from three to five). While such a change will ask for additional attention on the part of market scanners, it would not significantly drain additional resources. Hence, although it was initially expected that market turbulence will have a negative moderation effect on the relationships that defined Hypothesis 1 and Hypothesis 2, non-support of those assumption was not surprising.

Figure 4-3 Moderating Effect of TechTurb on TechScan-PIP Relationship



On the other hand, high level of technology turbulence will often be caused by additional complexity introduced by new developments in the technology domain. So, in order to keep up with the changes in the technology domain, firms will have to come up with additional resources to keep abreast of the changes. That means, if firms can not engage additional resources for technology-scanning to increase their absorptive capacity, their performance will fall behind. This characteristic difference between the turbulences in market domain and technology domain is reflected in the results found from the four moderation related hypothesis, it can be argued.

Figure 4-4 Moderating Effect of MktTurb on TechScan-PIP Relationship

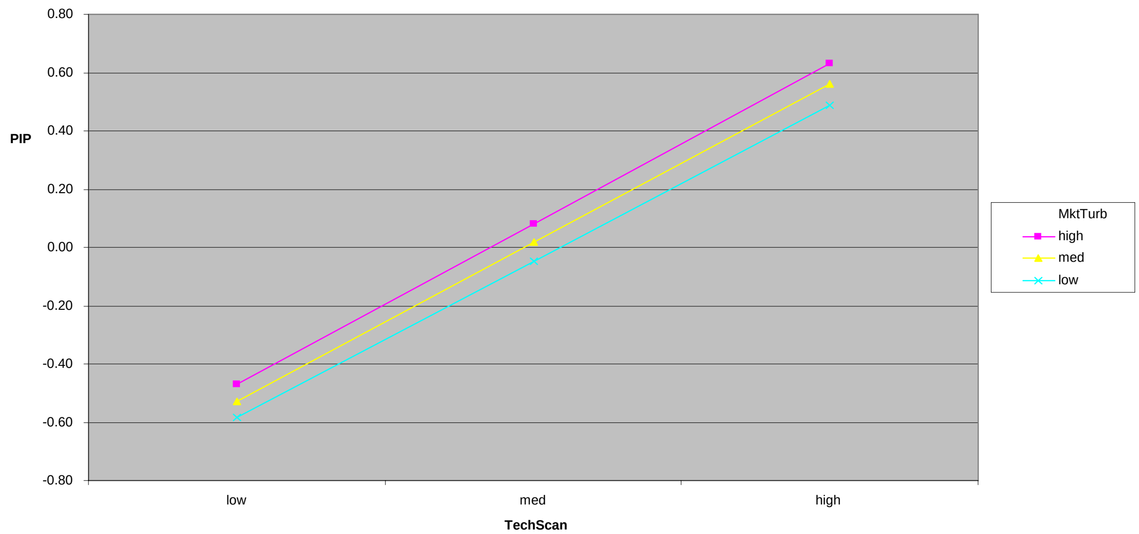
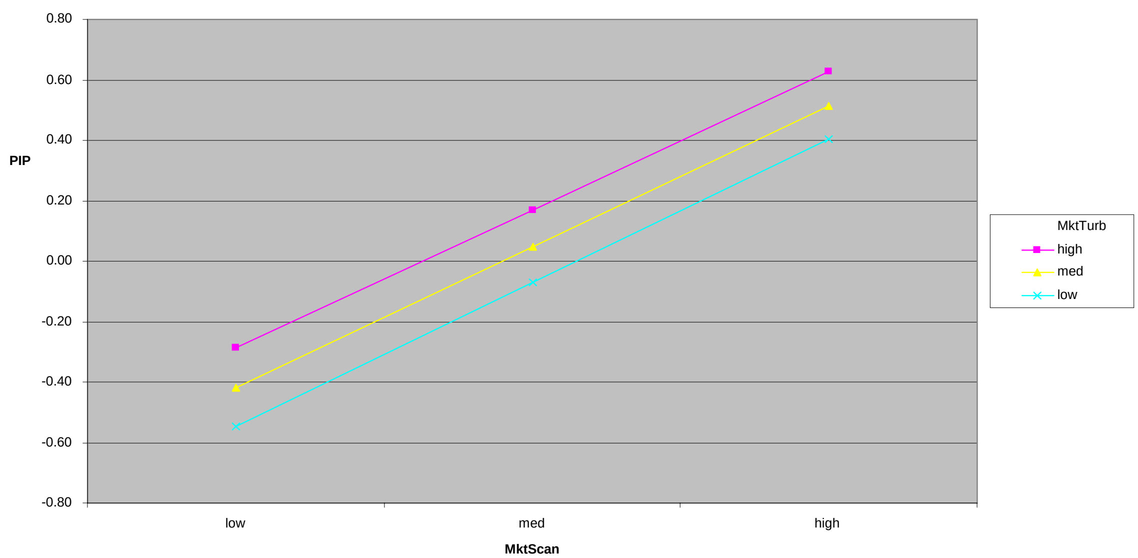


Figure 4-5 Moderating Effect of MktTurb on MktScan-PIP Relationship



4.11 Conclusion

This chapter presented the data analysis and results in several stages. First, it presented details of the development of the measurement scales for technology-scanning capability and market-scanning capability constructs. Later, other scales corresponding to product innovation performance, overall firm performance, market turbulence and technology turbulence constructs were reconfirmed – the scale items of which were taken directly from existing literature. Then, the overall research model was examined by testing the individual hypotheses. The influences of two types of scanning capabilities on product innovation performance and overall firm performance were examined. The chapter also discussed the influence of different types environmental turbulences on the relationships examined. Next, Chapter 5 will conclude the dissertation with a discussion of summary findings of the study, a review of the research questions, a discussion of the limitations of the study and the implications of the findings for the researchers and practitioners. Chapter 5 also explored future research opportunities that the current study highlights.

Chapter 5
Contributions, Limitations and Future Directions

5.1 Introduction

Literature suggested that firms collect and process information regarding technological options in addition to identifying market opportunities (Day 1994; Atuahene-Gima 1996; Deshpande and Farley 1998; Li and Calantone 1998; Baker and Sinkula 1999; Cadogan et al. 1999; Dawes 2000; Morgan and Strong 2003; Rohrbeck et al. 2006). A new scale called TechScan was created to measure firms' technology-scanning capability; while another scale to measure firms' market-scanning capability, MktScan, was developed.

Technology-scanning capability helps firms translate the knowledge acquired using market-scanning capability into performance by enabling them to find suitable ways to implement new products and services. Conversely, market-scanning capability enables firms to find market applications for technological opportunities that were recognized using technology-scanning capability. While both of these sequences of processes might co-exist within a given firm, there could be prevalence of one particular sequence within a firm depending on the technology-push or market-pull characteristics of firm culture and/or the specific industries that the firm operates in.

Both TechScan and MktScan scales were used to test an extended research model that captured the interactions among technology-scanning capability, market-scanning capability and firm performance. Firm performance was represented with two constructs in two stages – product innovation performance (Alegre et al. 2006) and overall firm performance (Jaworski and Kohli 1993; Han et al. 1998; Olson et al. 2005). 'Product innovation performance' was used to examine the direct influence of technology-scanning capability and market-scanning capability. This intermediate performance benchmark was then related to final business outcomes measured by 'overall firm performance'. Then, mediation roles of TechScan and MktScan capabilities were examined. When firms had relatively higher MktScan capability, their TechScan capability was expected to exhibit mediation effect in influencing the relationship between MktScan and product innovation performance. Similarly, when firms had relatively higher TechScan capability, their MktScan capability was expected to mediate the relationship between TechScan and product innovation performance.

Different firms experience different levels of rate of change in market domain and technology domain. These differing levels of turbulence in the business environment were expected to moderate the relationships between two scanning capabilities and performance measures. Effects of environmental turbulence (Dess and Beard 1984) on the overall research model were examined using two different scales to capture two aspects of environmental turbulence. The market turbulence scale captured the state of flux in firm's extended market (Jaworski and Kohli 1993; Narver et al. 2004; Olson et al. 2005) and technology turbulence scale measured the state of flux in the technological field relevant to the firm's business operations (Kohli and Jaworski 1990; Slater and Narver 1994; Narver et al. 2004; Olson et al. 2005).

5.2 Development of the TechScan and MktScan Scales

In the face of increasingly uncertain future, today's firms are increasingly engaged in information collection, information processing and dissemination of this information in order to prepare to adapt to the new realities. Sense and respond framework (Haeckel 1999; Haeckel 2000; Day and Schoemaker 2006) provided a guideline about how Information Age firms may prepare for their challenges (Huber 1984). Two scanning capabilities (TechScan and MktScan) were conceptualized that help firms to sense the weak signals (Ansoff 1975) in technology and market domains. Off these two, TechScan scale was developed from the scratch, while MktScan scale was developed by making use of existing market orientation scales (Kohli and Jaworski 1990; Narver and Slater 1990; Narver et al. 2004) from the literature.

A grounded theory approach (Martin and Turner 1986) was taken to develop a scale to measure firm-level technology-scanning capability following the guidelines for scale development in the literature (e.g.,Churchill 1979; Gerbing and Anderson 1988; Spector 1992; DeVellis 2003; Worthington and Whittaker 2006). First, a list of potential scale items based on the relevant qualitative and quantitative researches was created. These items were then consolidated into several common themes based on the theoretical understanding of the proposed construct. These were further refined and validated using the insights gained through a series of opinion survey of experts and practitioners and further review of the items were performed by the researcher and his colleagues. The final list was used to develop a survey instrument; along with items for other scales and demographic questions. The national survey was conducted through the web since this approach had benefits of speed, ease of access, anonymity and reasonable cost (Ilieva et al. 2002; Cole 2005; Evans and Mathur 2005; Wright 2005). Once data was collected, further refinement of the scale was done through exploratory factor analysis. The model of the TechScan scale clarified the underlying theoretical structure of this construct. A second-order reflective model was found to be appropriate that included four first-order components. The four of the important aspects of this capability were identified as: technological information gathering, technology alignment, responsiveness to collected technology-related information and exploitation of existing technology portfolio. It also provides a guideline for the practitioner managers who are interested to develop a mature TechScan capability within their firm.

The scale for MktScan capability was also found to be a second-order reflective construct with four other first-order components. The four important aspects of this capability were identified as: collection of information about customers, information regarding competitiveness, responsiveness to collected market-related information and coordination among different business units of the firm. This theoretical understanding of MktScan capability would also be helpful for the practitioners as they would be able to focus on the important components of this capability if they were to develop a mature market-scanning capability within their firms.

5.3 Review of Results

This study examined how two intangible resources of technology-scanning capability (TechScan) and market-scanning capability (MktScan) influenced firms' performance. Firm performance was treated with two constructs – product innovation performance and overall firm performance. The product innovation performance was an intermediate measure of performance that isolated the outcome of firms' internal activities from other external influences to some extent. The relationships among technology-scanning capability, market-scanning capability and product innovation performance were examined. Both TechScan and MktScan were found to have significant influence on firms' product innovation performance.

Moreover, each of these capabilities was found to be mediating the relationship between the other scanning capability and product innovation performance. Intuitively, this made sense, as opportunities or threats sensed in market domain using market-scanning capability would need to be acted upon likely by the knowledge acquired through using technology-scanning capability. Conversely, if a firm identified an opportunity or a threat by using technology-scanning capability first, then, the firm would likely respond to that through using market-scanning capability. It seems likely that, irrespective of the sequence of sense-and-respond cycle being followed, firms would enhance their product innovation performance and hence business performance.

During empirical analysis, the mediating roles of TechScan and MktScan capabilities were validated; these roles were found to be stronger when there was an imbalance between the strength of these two capabilities within a firm. Firms having higher levels of market-scanning capability compared to their technology-scanning capability were hypothesized to exhibit stronger mediation effect of technology-scanning capability. In other words, technology-scanning capability mediated the relationship between market-scanning capability and product innovation performance. This mediation effect was found to become stronger when MktScan > TechScan, compared with other cases when MktScan < TechScan or for full dataset. Conversely, firms having higher levels of technology-scanning capability compared to their market-scanning capability were hypothesized to exhibit stronger mediation effect of market-scanning capability. It was also found that mediation effects of MktScan on TechScan-PIP relationship became stronger when TechScan > MktScan, compared with other cases when TechScan < MktScan or for full dataset.

From both the cases, it could be argued that firms benefit from a balance between the TechScan capability and MktScan capability. Also, if there were an imbalance between these two scanning capabilities, managers within firms that have relatively stronger TechScan capability should have more urgency to increase their MktScan capability in order to increase their product innovation performance. This was demonstrated in the relatively higher mediation ratio of 0.607 for MktScan (for 123 cases when TechScan>MktScan; Table 4.13) compared to the mediation ratio of 0.503 for TechScan (for 257 cases when MktScan>TechScan; Table 4.12).

The research model was proposed to show sensitivity to turbulence in the business environment in which firms operated. Two measures were used to capture environmental turbulence: market turbulence (Narver et al. 2004) to measure the turbulences in the market environment (e.g., changes in customer need) of the firm, and technology turbulence (Olson et al. 2005) to measure the turbulences in the technological field that were relevant to the operations of the firm (e.g., duration of technology life cycle). Technology turbulence was found to be significantly moderating the relationship between technology-scanning capability and product innovation performance. However, market turbulence didn't have much influence on either of the relationships that defined Hypothesis 1 and Hypothesis 2. This difference in the moderation effect of two turbulences reflects the characteristic differences between the changes in the two domains – market and technology. While changes in either domain add to challenges of firms, market domain changes are often repetitive. Hence, turbulence in market domain has less effect compared to the changes in technology domain where additional turbulence are often result of added uncertainty introduced by complex nature of technological development. Table 5-1 summarized the findings in terms of validating the proposed hypotheses.

Table 5-1 Summary of Findings of Hypothesis Testing

Hypotheses	Findings
H1: Firms with higher level of technology-scanning capability will have a higher level of product innovation performance.	Supported
H2: Firms with higher level of market-scanning capability will exhibit a higher level of product innovation performance.	Supported
H3a: In case of firms with relatively stronger market-scanning capability, technology-scanning capability will mediate the relationship between market-scanning capability and product innovation performance.	Supported
H3b: In case of firms with stronger technology-scanning capability greater than market-scanning capability, market-scanning capability will mediate the relationship between technology-scanning capability and product innovation performance.	Supported
H4: Firms with higher product innovation performance have higher overall firm performance.	Supported
H5: The relationship between market-scanning capability and product innovation performance is negatively moderated by higher levels of technology turbulence.	Not Supported
H6: The relationship between technology-scanning capability and product innovation performance is negatively moderated by higher levels of technology turbulence.	Supported
H7: The relationship between market-scanning capability and product innovation performance is negatively moderated by higher levels of market turbulence.	Not Supported
H8: The relationship between technology-scanning capability and product innovation performance is negatively moderated by higher levels of market turbulence.	Not Supported

5.4 Review of Research Questions

In the face of constant change in their business environment, firms experience difficulty in planning for an uncertain future. To avoid this hardship, a sense-and-respond framework was suggested by other authors (Haeckel 1999; Haeckel 2000; Day and

Schoemaker 2006). Instead of planning for an uncertain future, the framework promoted, firms would benefit if they learned to become adaptive to changes in their business environment. In this changed business scene, an important capability that firms needed to develop is to sense what kind of changes were to expect – both in market domain and in technology domain. The current study developed scales to measure two such capabilities of firms, namely technology-scanning capability and market-scanning capability. In the context of findings from hypothesis testing discussed above, following is a discussion on the research questions, originally introduced in Section 1.2:

How should firms proceed to gain knowledge about 'what are the customers' needs' and 'how to implement those needs'?

In order to become adaptive and apply the sense-and-respond framework effectively, firms needed to develop capabilities to enable themselves to foresee the changes that were going to affect their business in near future. For any business firm, changes might come from different domains such as market or technology. Because of the distributed nature of the changes that happen in the market domain and in the technology domain, sensing these changes was more challenging. The current study coined the term market-scanning capability in the context of scholarly research and this capability enables a firm to sense the changes in the customer needs, among others. Also, once a firm sensed a particular new customer need or a change in an existing customer need, it needed to find a tangible way to satisfy that need in its products and services. The current study also proposed the concept of technology-scanning capability to capture the aspects of firms' ability to find out the ways to implement the new customer needs. To summarize, firms need to develop their market-scanning capability to better understand their customers' needs. Firms also need to develop their technology-scanning capability to improve their ability to implement those customers' needs.

Whether the market-pull and technology-push characteristics of the firms have an influence *on how market-scanning capability and technology-scanning capability play their role to achieve performance?*

The current study found that both technology-scanning capability and market-scanning capability had a significant influence in strengthening firms' product innovation performance. Looking closely at each of the sense-and-respond cycle, a firm might sense an opportunity or a threat by using either MktScan or TechScan capability and then respond to that information by using either of the two capabilities. However in many cases, a firm might be inclined to use their market-scanning capability more often to find market opportunities and then use its technology-scanning capability to find a tangible way to benefit from that opportunity (i.e., respond to it). In such cases, firms can be said to have market-pull characteristics and TechScan capability was found to meditate the relationship between MktScan capability and product innovation performance.

There would be other cases when firms use their technology-scanning capability more often to recognize signals in the technology domain and respond to those signals by using market-scanning capability to find suitable applications for the new technological opportunities. In these cases, MktScan capability would meditate the relationship between TechScan capability and product innovation performance. The current study found support for both of these mediation relationships. The findings also implied that firms with particular preference for market-scanning or technology-scanning would be benefited from their effort to bring balance between these two capabilities.

How do firms ensure that their performance is sustainable over an extended period?

The current study argued on a conceptual level that sustainable competitive advantage can be gained by firms by achieving a higher level of product innovation performance. Firms would do that by increasing the strength of their two intangible resources – technology-scanning capability and market-scanning capability. For the managers interested in increasing TechScan capability of their firms, the study suggests that they can do it by focusing on four major components: technological information gathering, technology alignment, responsiveness to collected technology information and exploitation of technology. Similarly, for the managers who are interested to develop their MktScan capability of their firms, the study suggests that they should focus on improving these four areas: collection of information about customers, information related to competition, responsiveness to the collected market information and coordination among the different business units of their firms. Once firms achieved the required strength of these intangible resources, they were not expected to lose those in a short time. Low fungibility of these intangible resources would lead firms to achieve higher product innovation performance that would also be less fungible. A relatively stable and high level of product innovation performance was expected to generate high level of overall business performance over time.

How do the turbulences in the business environment in which firms operate influence other relationships?

Intuitively, turbulences in the business environment were expected to influence the relationship between firm's capabilities and performance. The current study hypothesized that both market turbulence and technology turbulence would moderate the relationships between technology-scanning capability and product innovation performance, and between market-scanning capability and product innovation performance. However, the findings supported only one of the four proposed moderation relationships as significant. A higher level of technology turbulence was found to negatively moderate the relationship between technology-scanning capability and product innovation performance.

5.5 Limitations of the Research

When developing the TechScan model, the firms were not limited to a certain type for which technology-scanning capability construct might be highly relevant, as the theory does not depend on the specific aspects of any industrial sector or types of firms. The same argument was true to the overall research model, and it was expected to be equally applicable for the varieties of business conditions. When collecting data, however, firms that were primarily in the business of manufacturing products were selected. This provided a moderate choice as opposed to the two other extreme choices for selecting a sample population to test the research model. A more general population of firms could have been selected for the national survey. While that choice might have caused the result to be widely generalizable, it entailed the risk of being too broad for an exploratory type of study. Another option was to collect data from a more selective group of firms focused on a specific type of customers or a specific industry. Since new products in a single industry are more homogenous with regards to technology and their economic effects, analysis of data focused on a single industrial sector often was more useful (Santarelli and Piergiovanni 1996). At the cost of being too narrow, it might have enabled a deeper understanding of the chosen industry or chosen customer segment, in addition to the prospect for a more relevant and stronger result. Focusing on a specific industry or a specific type of customers could have, however, limited the sample size and, thereby, potentially decreasing the strength of quantitative analysis.

5.6 Future Research

As it was implied in previous section, it would be useful to replicate the research in different settings. A specific industry could be selected to recruit survey participants and monitor their responses to analyze the effect of technology-scanning capability and market-scanning capability on firm performance. It would be interesting to compare outputs among a few focal industries and examine whether a certain industry makes more use of either technology-scanning capability or market-scanning capability. It would also be interesting to explore the underlying causes (e.g., competitive pressure) that might be responsible for increased use of a certain scanning capability – if that is found to be the case - in a certain industrial sector. Comparative studies from different industries might also shed light on how product innovation performance translated into overall firm performances.

5.7 Theoretical and Practical Implications and Conclusion

The findings of this study provided important insights for practitioners as well as researchers. First, an important construct called TechScan was developed and its psychometric properties were reported. This scale could be used to measure firm-level technology-scanning capability. Another construct called MktScan was also developed that could be used to measure firm-level market-scanning capability. The usefulness of these capabilities are even more important since firms are becoming more interested to know about ongoing changes in market and technology domains externally as a result of the increasing popularity of open innovation practices (Chesbrough et al. 2006). Indeed, Chesbrough (2003) stated that the job of R&D managers involved not only managing within the company but also looking beyond the firm boundary and managing the network relations to take advantage of other firms' technological efforts. Similarly, chief innovation officers or CEOs are interested to know about market dynamics to find the external opportunities that existed. Alliances, mergers, acquisitions are also frequently used as tactical tools to practice open innovation. Hence, an improved level of technology-scanning capability and market-scanning capability of firms would be helpful to execute the open innovation strategy of firms.

Both models of these constructs comply with the generic definition of capability where a capability delivers a goal. The goal is achieved through a combination of processes, tools, knowledge, skills, and organization that are all focused on meeting the desired result. Each of the scanning capabilities was found to mediate the relationship between other scanning capability and product innovation performance. Results also implied that technology-push firms will benefit more – if they improve the balance between these two capabilities. Firms operating in technologically volatile environments will need to improve their TechScan capability to maintain their product innovation performance. Overall, the study connected two important theoretical concepts of sense-and-respond framework and resource-based view of firms to put together a theoretical foundation for creating adaptive enterprises.

The models of technology-scanning capability and market-scanning capability themselves provided useful insights into what practitioners might pay attention to. The models of TechScan and MktScan constructs could be used as benchmark tools. These models could also be used to better design business processes that do the gathering, processing, and analyzing of information from both technology domain and market domain. Overall, the results of this study improved the understanding of the use of the resource-based view of firms to examine how firms achieved sustainable competitive advantage. On a more theoretical level, the study illustrated how two intangible resources of firms interact with each other to create sustainable competitive advantage.

Appendix A

Potential Items for Technology-Scanning Capability Scale

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension I	**(i)Technology scanning starts where market orientation ends**	
	Marketing research skills and resources were more than adequate	Benedetto (1999)
Management Decision for Technology Scanning	Undertook market study well	Cooper (1979, 1980)
	Understood customer's needs, wants	Cooper (1979, 1980)
	Understood buyer price sensitivity	Cooper (1979, 1980)
	Understood competitive situation	Cooper (1979, 1980)
	Understood buyer behavior	Cooper (1979, 1980)
	Understood/knew size of potential market	Cooper (1979, 1980)
	Customers had great need for product type	Cooper (1979, 1980)
	Market determinateness (product clearly specified by marketplace)	Cooper (1979, 1980)
	Market-driven idea	Cooper (1979, 1980)
	Product was innovative - the first of its kind in the market	Cooper and Kleinschmidt (1987)
	Product solved a problem the customer had with competitive products	Cooper and Kleinschmidt (1987)
	Customer need level for product type	Cooper and Kleinschmidt (1987)
	Prior to product development, the product concept - what the product would be and do - was well defined.	Cooper and Kleinschmidt (1987)
	Prior to product development, the product specifications and requirements were well defined	Cooper and Kleinschmidt (1987)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
	Proficiencies of preliminary market assessment	Cooper and Kleinschmidt (1987)
	Product was superior to competitive products in the eyes of the customer	Cooper and Kleinschmidt (1987)
	Product definition prior to development	Cooper and Kleinschmidt (1995)
	Proficiencies of initial screening	Cooper and Kleinschmidt (1987)
	Prior to product development the customers' needs, wants, and preferences were well defined	Cooper and Kleinschmidt (1987)
	Product offered unique benefits to the customer - benefits not found in competitive products	Cooper and Kleinschmidt (1987)
	Prior to product development the target market was well defined	Cooper and Kleinschmidt (1987)
	Product was higher quality than competitive products	Cooper and Kleinschmidt (1987)
	Product reduced customers' cost	Cooper and Kleinschmidt (1987)
	Demand pull projects are more successful than the technology push projects	Gerstenfeld (1976)
	Better matched to customer needs	Maidique and Zirger (1984)
	Market forecast was done more accurately	Maidique and Zirger (1984)
	Developed with a clearer market strategy	Maidique and Zirger (1984)
	Innovations were directed more towards a market need versus a result of a technology opportunity	Maidique and Zirger (1984)
	Developed by teams which more fully understood user needs	Maidique and Zirger (1984)
	In the market longer before competing products introduced	Maidique and Zirger (1984)
	Knew customer needs, wants, and specification for product	Mishra et al. (1996)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
	Knew customer price sensitivity	Mishra et al. (1996)
	Knew competitor – e.g., products strategies.	Mishra et al. (1996)
	Understood buyer behavior	Mishra et al. (1996)
	Knew market size	Mishra et al. (1996)
	Existence of a mass market (as opposed to one or few customers)	Mishra et al. (1996)
	Degree of need for products in product class	Mishra et al. (1996)
	Existence of a potential demand only (no actual market)	Mishra et al. (1996)
	Frequency of new product introductions	Mishra et al. (1996)
	Degree to which users' needs change quickly in the market	Mishra et al. (1996)
	Extent of role of government in the marketplace	Mishra et al. (1996)
	Innovativeness of product to the market	
	Whether product was a custom product or not	Mishra et al. (1996)
	Whether product idea was market derived	Mishra et al. (1996)
	Market determinateness (whether product	Mishra et al. (1996)
	specifications were clearly defined by the marketplace)	Mishra et al. (1996)
	Whether the product was a defensive (as opposed to an offensive) introduction	Mishra et al. (1996)
	Preliminary market assessment	
	Detailed market study or market research	Mishra et al. (1996)
		Mishra et al. (1996)
	Product met customer needs better than competitors	Mishra et al. (1996)
	Product reduced customers' costs	Mishra et al. (1996)
	Product permitted customer to perform a unique task	Mishra et al. (1996)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
	Innovation helped increase the ability to adapt flexibly to different client demands	Statistics Canada (2003)
	Innovation helped enable the business unit to keep up with its competitors	Statistics Canada (2003)
	Innovation helped to improve product quality	Statistics Canada (1999)
	Innovation helped increased firm's ability to adapt flexibly to different client demands	Statistics Canada (1999)
	Innovation helped enable the firm to keep up with its competitors	Statistics Canada (1999)
	Innovation improve product quality	Statistics Canada (1996)
	Innovation develops environment friendly products	Statistics Canada (1996)
	Innovation increases productivity of customers	Statistics Canada (1996)
	Innovation increased the ability to meet ecological, medical or ergonomic requirements	Statistics Canada (1996)
	Innovation expanded market by increasing the range of goods and services provided to clients	Statistics Canada (1996)
	Innovation expanded market by increasing customers' quality of life	Statistics Canada (1996)
	Innovation increased QoS by increasing the ability to adapt flexibly to different customer requirements	Statistics Canada (1996)
	Innovation increased QoS by increasing user-friendliness of services / products	Statistics Canada (1996)
	Innovation increased QoS by increasing reliability of services / products	Statistics Canada (1996)
	Innovation increased the serviceability, durability, or recyclability of products	Statistics Canada (1996)
	Prediction of consumer demand correctly	Statistics Canada (1996)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension I (continued)	**(ii) Establish focus on technology to find tangible ways to solve customer problems**	
	Newness of production process to the firm	Mishra et al. (1996)
	Newness of technology to the firm	Mishra et al. (1996)
	Novelty of innovation lies in use of new materials	Statistics Canada (1996)
	Novelty of innovation lies in use of intermediate products	Statistics Canada (1996)
	Novelty of innovation lies in new functional parts	Statistics Canada (1996)
	Novelty of innovation lies in use of radically new technology	Statistics Canada (1996)
	Novelty of innovation lies in fundamental new functions	Statistics Canada (1996)
	Novelty of innovation lies in new production techniques	Statistics Canada (1996)
	Technical determinateness (whether the technical solution was clear at the beginning)	Mishra et al. (1996)
	(iii) Facilitate voluntary participation of potentially all employees	
TechScan Dimension I (continued)	Time off for creative things	Cooper and Kleinschmidt (1995)
	Firm encourages risk taking initiatives by employees	Statistics Canada (2003)
	Firm uses financial incentives to attract and retain employees only	Statistics Canada (2003)
	Innovation improve working conditions	Statistics Canada (1996)
	Innovation increases productivity of employees	Statistics Canada (1996)
	Innovation increases motivation of employees	Statistics Canada (1996)

Technology Scanning Dimensions	**List of Characteristics and Tasks**	**Reference**
	(iv) Organizational readiness – HR policy, processes and tools	
	Having a multidisciplinary team	Cooper and Kleinschmidt (1995)
	Formalized on paper sooner	Maidique and Zirger (1984)
	Innovations were developed by teams with higher education levels	Maidique and Zirger (1984)
	Innovations were developed by teams with newer employees	Maidique and Zirger (1984)
	Firm encourages experienced workers to transfer their knowledge to new or less experienced workers	Statistics Canada (2003)
	Firm uses teams which bring together people with different skills	Statistics Canada (2003)
	Firm regularly maintains databases of good work practices, lessons learned or listings of experts	Statistics Canada (2003)
	Firm documents lessons learned, training manuals, good work practices, articles for publication, etc.	Statistics Canada (2003)
	Firm uses a written knowledge management policy / strategy or a knowledge management officer	Statistics Canada (2003)
	Improved performance (including integrated software) specifically purchased to implement new or significantly improved products or processes	Statistics Canada (2003)
	Firm reimburses workers tuition fees for successfully completed work-related courses	Statistics Canada (2003)
	Firm offer off-site training to workers in order to keep skills current	Statistics Canada (2003)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
	Firm hire skilled workers	Statistics Canada (2003)
	Internal or external training for personnel directly aimed at the development and/or introduction of new or significantly improved products or processes	Statistics Canada (2003)
	Firm emphasizes using teams within firm which bring together people with different skills	Statistics Canada (1999)
	Innovation involved new software developed by or specifically for the firm	Statistics Canada (1999)
	Firm emphasizes hiring new graduates from universities	Statistics Canada (1999)
	Firm emphasizes hiring new graduates from technical schools and colleges	Statistics Canada (1999)
	Firm emphasizes hiring experienced employees	Statistics Canada (1999)
	Firm emphasizes recruiting skilled people from outside of Canada	Statistics Canada (1999)
	Firm emphasizes training employees	Statistics Canada (1999)
	Novelty of innovation lies in new organizational innovations w.r.t. the intro of new technology	Statistics Canada (1996)
	Novelty of innovation lies in new professional software developed by or specifically for the firm	Statistics Canada (1996)
	Human resources provide incentive compensation plans	Statistics Canada (1996)
	Human resources focus on recruiting skilled employees	Statistics Canada (1996)
	Human resources focus on training	Statistics Canada (1996)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension II	**(i) All sources of innovation are utilized as input**	
	Customer involvement	Cooper and Kleinschmidt (1995)
	Innovations required more interaction with users in the development stage	Maidique and Zirger (1984)
Sources of Information	Project teams interfaced with more with external resources	Maidique and Zirger (1984)
	Innovations depended more on technology developed externally	Maidique and Zirger (1984)
	What percentage of the employees has access to Internet from their desk	Statistics Canada (1996)
	Is the firm member of a cooperative or consortium	Statistics Canada (1996)
	Competitors in the same line of business are important source for innovation	Statistics Canada (1996)
	Clients or customers are important source for innovation	Statistics Canada (1996)
	Consultancy firms are important source for innovation	Statistics Canada (1996)
	Suppliers of equipment, material and components are important source for innovation	Statistics Canada (1996)
	Government information programs are important source of information for innovation	Statistics Canada (1996)
	Fairs, exhibitions are important source of information for innovation	Statistics Canada (1996)
	Professional conferences, meetings, publications are important source of information for innovation	Statistics Canada (1996)
	Gatherings of social nature are important source of information for innovation	Statistics Canada (1996)
	Patent literature are important source of information for innovation	Statistics Canada (1996)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
	University and other higher educational institutions are important source of information for innovation	Statistics Canada (1996)
	Government research institutions are important source of information for innovation	Statistics Canada (1996)
	Private research institutions are important source of information for innovation	Statistics Canada (1996)
	External sources of information for innovation was related firms in your corporate group	Statistics Canada (1999)
	External sources of information for innovation was clients	Statistics Canada (1999)
	External sources of information for innovation was competitors	Statistics Canada (1999)
	External sources of information for innovation was consultancy firms	Statistics Canada (1999)
	External sources of information for innovation was universities and colleges	Statistics Canada (1999)
	External sources of information for innovation was federal government agencies and research laboratories (e.g. National Research Council of Canada)	Statistics Canada (1999)
	External sources of information for innovation was provincial agencies and research laboratories	Statistics Canada (1999)
	External sources of information for innovation was trade fairs and exhibitions	Statistics Canada (1999)
	External sources of information for innovation was internet or computer based information networks	Statistics Canada (1999)
	External sources of information for innovation was professional conferences, meetings and publications	Statistics Canada (1999)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
	Internal sources of information for innovation was research and development (R&D) staff	Statistics Canada (1999)
	Internal sources of information for innovation was production staff	Statistics Canada (1999)
	Internal sources of information for innovation was management staff	Statistics Canada (1999)
	Internal sources of information for innovation was marketing staff	Statistics Canada (1999)
	Internal sources of information for innovation was sales and marketing staff	Statistics Canada (2003)
	Internal sources of information for innovation was production staff	Statistics Canada (2003)
	Internal sources of information for innovation was management staff	Statistics Canada (2003)
	Internal sources of information for innovation was other business units in the firm	Statistics Canada (2003)
	Internal sources of information for innovation was research and development (R&D) staff	Statistics Canada (2003)
	Firm uses partnerships, strategic alliances or joint ventures to acquire knowledge	Statistics Canada (2003)
	Firm has geographic proximity to clients and suppliers	Statistics Canada (2003)
	Firm has geographic proximity to knowledge institutions (e.g., universities, research institutes)	Statistics Canada (2003)
	Firm has geographic proximity to sources of venture capital	Statistics Canada (2003)
	Firm participates in local and regional industry associations	Statistics Canada (2003)

Technology Scanning Dimensions	**List of Characteristics and Tasks**	**Reference**
	R&D carried out performed by other firms or organizations (including contracted out R&D and R&D carried out by other business units within the firm or within joint ventures) led to new or significantly improved products and processes.	Statistics Canada (2003)
	External sources of information for innovation was suppliers of software, hardware, materials, or equipment	Statistics Canada (2003)
TechScan Dimension III **Responsiveness to Technology Scanning Outcome**	**(i) Responsiveness to technology scanning – Usage level of outcome**	
	Purchase of rights to use patents and non-patented inventions, licenses, know-how, trademarks, software and other types of knowledge from others for the development of new or significantly improved products and processes	Statistics Canada (2003)
	Innovation helped to deal with or to respond to new government regulations	Statistics Canada (1999)
TechScan Dimension IV **Level of Shared Sense of Future**	**Level of shared sense of future among all employees and stakeholders**	
	Interdepartmental committees were set up to allow departments to engage in joint decision-making	Benedetto (1999)
	Task forces or temporary groups were set up to facilitate interdepartmental collaboration	Benedetto (1999)
	Innovations had more project reviews during development and commercialization	Maidique and Zirger (1984)
	Consensus decision making is done	Statistics Canada (1996)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension V	**(i) Synergy with technological trend in the market place is emphasized**	
	High growth market	Cooper (1979, 1980)
	Closer to the state-of-the-art technology	Maidique and Zirger (1984)
Specific Goals Pursued Through Technology Scanning	Firm emphasizes active involvement in developing new industry-wide standards	Statistics Canada (1999)
	Firm is actively involved in developing new industry-wide standards	Statistics Canada (2003)
	(ii) Compatibility with firm's existing technologies, resources and competencies	
	Sales force skills and resources were more than adequate	Benedetto (1999)
	Distribution skills and resources were more than adequate	Benedetto (1999)
	Advertising and promotion skills and resources were more than adequate	Benedetto (1999)
TechScan Dimension V (continued)	Engineering skills and resources were more than adequate	Benedetto (1999)
	Manufacturing skills and resources were more than adequate	Benedetto (1999)
	Had compatible engineering skills for project	Cooper (1979, 1980)
	Had compatible production resources for project	Cooper (1979, 1980)
	Knew product technology well	Cooper (1979, 1980)
	A good fit between the needs of the project and the customer services resources skills	Cooper and Kleinschmidt (1987)
	A good fit between the needs of the project and the RD or product development skills and resources	Cooper and Kleinschmidt (1987)
	A good fit between the needs of the project and the engineering skills and resources	Cooper and Kleinschmidt (1987)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension V (continued)	A good fit between the needs of the project and production resources and skills	Cooper and Kleinschmidt (1987)
	New products generally aimed at familiar markets	Cooper and Kleinschmidt (1995)
	Closer to the main business area of firm	Maidique and Zirger (1984)
	More influenced by corporate reputation	Maidique and Zirger (1984)
	Innovations required less change in the firm's strategy	Maidique and Zirger (1984)
	Compatible financial resources of the firm	Maidique and Zirger (1984)
	Compatible R&D skills and people	Maidique and Zirger (1984)
	Compatible engineering skills and people	Maidique and Zirger (1984)
	Compatible marketing research skills and people	Maidique and Zirger (1984)
	Compatible management skills	Maidique and Zirger (1984)
	Compatible production resources and skills	Maidique and Zirger (1984)
	Compatible sales force and / or distribution resources and skills	Maidique and Zirger (1984)
	Compatible advertising and promotion skills and resources	Maidique and Zirger (1984)
	Understood product's technology	Maidique and Zirger (1984)
	Understood product design well - all design bugs ironed out	Maidique and Zirger (1984)
	In-house R&D department is important source for innovation	Statistics Canada (1996)
	R&D capabilities	Statistics Canada (1996)
	Innovation extend product range within main product field	Statistics Canada (1996)
	Internal sources of information for innovation was research and development (R&D) staff	Statistics Canada (2003)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension V (continued)	**(iii) Exploitation of technology portfolio in new international market – for both acquisition and sales**	
	Innovation require protection through copyrights	Statistics Canada (1996)
	Innovation require protection through patents	Statistics Canada (1996)
	Innovation require protection through industrial design	Statistics Canada (1996)
	Innovation require protection through trade secrets	Statistics Canada (1996)
	Innovation require protection through trademarks	Statistics Canada (1996)
	Innovation require protection through integrated circuit design (semiconductor chips)	Statistics Canada (1996)
	Innovation require protection through plant breeders rights (plant variety rights)	Statistics Canada (1996)
	The need for protection was partly achieved through the complexity of product design	Statistics Canada (1996)
	Intellectual property exchange is done	Statistics Canada (1996)
	Protecting products / processes with intellectual property rights (patents, trademarks, etc)	Statistics Canada (1996)
	Innovation open up new markets in new domestic target groups	Statistics Canada (1996)
	Innovation open up new markets in international market	Statistics Canada (1996)
	Marketing target new foreign markets	Statistics Canada (1996)
	Marketing target new domestic markets	Statistics Canada (1996)
	Innovation is a world first	Statistics Canada (1996)
	Innovation is a national first	Statistics Canada (1996)
	Innovation is a local market first	Statistics Canada (1996)

Technology Scanning Dimensions	**List of Characteristics and Tasks**	**Reference**
TechScan Dimension V (continued)	If not a world first, where did it originated	Statistics Canada (1996)
	If not a world first, how much time did it took to adapt	Statistics Canada (1996)
	Firm emphasizes seeking new markets	Statistics Canada (1999)
	Firm emphasizes developing niche or specialized markets	Statistics Canada (1999)
	Firm emphasizes developing export markets	Statistics Canada (1999)
	Innovation helped increased firm's domestic market share	Statistics Canada (1999)
	Innovation helped increased firm's international market share	Statistics Canada (1999)
	Collaboration was done to access new markets	Statistics Canada (1999)
	Collaboration was done to access new distribution channels	Statistics Canada (1999)
	Firm emphasizes developing niche or specialized markets	Statistics Canada (2003)
	Firm emphasizes developing export markets	Statistics Canada (2003)
	Collaboration was done to access new markets	Statistics Canada (2003)
	Collaboration was done to access new distribution channels	Statistics Canada (2003)
	Innovation helped increase business unit's international market share	Statistics Canada (2003)
	(iv) Distinguish between ways to make incremental vs. radical innovation	
	Potential customers were new to firm	Cooper (1979, 1980)
	Product class new to firm	Cooper (1979, 1980)
	Product use (need served) new to firm	Cooper (1979, 1980)
	Production process new to firm	Cooper (1979, 1980)
	Product technology new to firm	Cooper (1979, 1980)
	Distribution, sales force new to firm	Cooper (1979, 1980)
	Advertising, promotion new to firm	Cooper (1979, 1980)

Technology Scanning Dimensions	**List of Characteristics and Tasks**	**Reference**
TechScan Dimension V (continued)	New competitors for the firm	Cooper (1979, 1980)
	Highly innovative product, new to market	Cooper (1979, 1980)
	Product had unique features for customer	Cooper (1979, 1980)
	Superior to competing products in meeting customer's needs	Cooper (1979, 1980)
	Product did unique task for customer	Cooper (1979, 1980)
	Product higher quality than competitors'	Cooper (1979, 1980)
	A high technology product	Cooper (1979, 1980)
	Intensity of competition in the marketplace	Cooper and Kleinschmidt (1987)
	Degree of price competition in the marketplace	Cooper and Kleinschmidt (1987)
	Strength and quality of competitors' products	Cooper and Kleinschmidt (1987)
	More difficult for competition to copy	Maidique and Zirger (1984)
	More radical with respect to world technology	Maidique and Zirger (1984)
	Innovations used more technology outside the firm's area of expertise	Maidique and Zirger (1984)
	Innovations require a more technically oriented user	Maidique and Zirger (1984)
	Novelty of innovation lies in new organizational innovations w.r.t. the intro of new technology	Statistics Canada (1996)
	Novelty of innovation lies in new professional software developed by or specifically for the firm	Statistics Canada (1996)
	Novelty of innovation lies in use of new materials	Statistics Canada (1996)
	Novelty of innovation lies in use of intermediate products	Statistics Canada (1996)
	Novelty of innovation lies in new functional parts	Statistics Canada (1996)
	Novelty of innovation lies in use of radically new technology	Statistics Canada (1996)

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension V (continued)	Novelty of innovation lies in fundamental new functions	Statistics Canada (1996)
	Novelty of innovation lies in new production techniques	Statistics Canada (1996)
	Innovation helps maintain market share	Statistics Canada (1996)
	Innovation helps increase market share	Statistics Canada (1996)
	Acquisition of embodied technology equipment is important source for innovation	Statistics Canada (1996)
	Consumers can not easily substitute among competitive product	Statistics Canada (1996)
	Developing new or refining existing technology	Statistics Canada (1996)
	Emphasis on continuous quality improvement	Statistics Canada (1996)
	Customization of products is an important component in competitive strategy	Statistics Canada (1996)
	Innovation require protection through patents	Statistics Canada (1996)
	Intellectual property exchange is done (acquire	Statistics Canada (1996)
	IP right to use from other firm or assign the right to others to use)	Statistics Canada (1996)
	Protecting products / processes with intellectual property rights (patents, trademarks, etc)	Statistics Canada (1999)
	R&D led to new or significantly improved products	Statistics Canada (1999)
	R&D led to new or significantly improved production / manufacturing processes	Statistics Canada (1999)
	Acquisition of machinery, equipment or other technology led to new or significantly improved products	Statistics Canada (1999)
	Acquisition of machinery, equipment or other technology led to production / manufacturing processes	Statistics Canada (1999)
	Industrial engineering and industrial design led to new or significantly improved products	

Technology Scanning Dimensions	List of Characteristics and Tasks	Reference
TechScan Dimension V (continued)	Industrial engineering and industrial design led to new or significantly improved production / manufacturing processes	Statistics Canada (1999)
	Tooling up and production start-up led to new or significantly improved products (goods or services)	Statistics Canada (1999)
	Internal or external marketing activities directly aimed at the development and/or introduction of new or significantly improved products (goods or services)	Statistics Canada (2003)
	(v) Specific attention is paid to achieve cost reduction in present products	
	Product let customer reduce his costs	Cooper (1979, 1980)
	Innovation reduces production cost by reducing unit labor costs	Statistics Canada (1996)
	Innovation reduces production cost by cutting consumption of materials	Statistics Canada (1996)
	Innovation reduces production cost by cutting energy consumption	Statistics Canada (1996)
	Innovation reduces production cost by reducing product design costs	Statistics Canada (1996)
	Innovation reduces production cost by reducing production lead times	Statistics Canada (1996)
	Emphasis on high quality suppliers	Statistics Canada (1996)
	Emphasis on reducing production times	Statistics Canada (1996)
	Emphasis on improving efficiency of input (materials or services) use	Statistics Canada (1996)
	Innovation helped to reduce your labor costs	Statistics Canada (1999)
	Innovation helped to increase production capacity	Statistics Canada (1999)
	Innovation helped to reduce production time	Statistics Canada (1999)

Technology Scanning Dimensions	**List of Characteristics and Tasks**	**Reference**
TechScan Dimension V (continued)	Innovation helped to improve production flexibility	Statistics Canada (1999)
	Innovation helped to reduce materials consumption	Statistics Canada (1999)
	Innovation helped to reduce environmental damage	Statistics Canada (1999)
	Innovation helped to reduce energy consumption	Statistics Canada (1999)
	Innovation helped increase the productivity of the firm	Statistics Canada (1999)
	Collaboration was done to access critical expertise	Statistics Canada (1999)
	Innovation helped increased the profitability of the firm	Statistics Canada (1999)
	Innovation helped enable the firm to maintain its profit margins	Statistics Canada (1999)
	Collaboration was done to share cost	Statistics Canada (1999)
	Collaboration was done to access critical expertise	Statistics Canada (2003)
	Innovation helped increase the business unit's productivity	Statistics Canada (2003)
	Innovation helped enable decrease the cost of producing products (goods or services)	Statistics Canada (2003)

Appendix B

Validation of Components of Technology Scanning Scale

<table>
<tr><th>Components</th><th colspan="8">Feedback</th></tr>
<tr><td rowspan="2">Management Decision for Technology Scanning</td><td colspan="5">A good representation?</td><td colspan="2">Drop this?</td><td>Substitute?</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Y</td><td>N</td><td></td></tr>
<tr><td rowspan="2">Sources of Information</td><td colspan="5">A good representation?</td><td colspan="2">Drop this?</td><td>Substitute?</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Y</td><td>N</td><td></td></tr>
<tr><td rowspan="2">Responsiveness and Usage Level of Outcome</td><td colspan="5">A good representation?</td><td colspan="2">Drop this?</td><td>Substitute?</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Y</td><td>N</td><td></td></tr>
<tr><td rowspan="2">Level of Shared Sense of Future</td><td colspan="5">A good representation?</td><td colspan="2">Drop this?</td><td>Substitute?</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Y</td><td>N</td><td></td></tr>
<tr><td rowspan="3">Specific Goals Pursued Through Technology Scanning</td><td colspan="5">A good representation?</td><td colspan="2">Drop this?</td><td>Substitute?</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Y</td><td>N</td><td></td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>Y</td><td>N</td><td></td></tr>
<tr><td colspan="9">Others</td></tr>
<tr><td colspan="9">Additional Overall Comments:

Do you think the above components are a good representation of the concept called "Technology Scanning"

Would you suggest dropping any of the components or modifying the existing representation in any way?

Would you suggest adding any new components to the existing list?</td></tr>
</table>

Appendix C

Validation of Sub-Components of Technology Scanning Scale

Component	Sub-component	Feedback							
Management Decision for Technology Scanning	(i) Antecedent role of market orientation (MO)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(ii) Focus on technology (Always consider the technology option, if there is one, while tackling an issue)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iii) Voluntary participation of potentially all employees	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iv) Organizational readiness (HR Policy, Processes, Tools	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(v) Others								
Sources of Information	(i) Internal Sources (within organization)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(ii) Internal Sources (outside immediate organization, but within organizational network)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iii) External Sources (within national boundary)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iv) External Sources (outside national boundary)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(v) Others								
Responsiveness and Usage Level of Outcome	(i) Perception of responsiveness in strategic matters	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(ii) Perception of responsiveness in operational	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	

Component	Sub-component	Feedback							
	matters								
	(iii) Evidence of using technology scanning outcome in strategic matters (anecdotal evidence from past experience)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iv) Evidence of using technology scanning outcome in operational matters (anecdotal evidence from past experience)	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(v) Others								
Level of Shared Sense of Future	(i) Perception of shared sense (uniformity) among all employee groups within the organization	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(ii) Perception of shared sense (uniformity) among all stakeholders within firm's network	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iii) Anecdotal evidence in support or against this shared sense within organization	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iv) Anecdotal evidence in support or against this shared sense within firm's network	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(v) Others								
Specific Goals Pursued Through Technology	(i) Synergy with technological trends in the market	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(ii) Compatibility with firm's	A good representation?					Drop this?		Substitute?

Component	Sub-component	Feedback							
Scanning	existing technologies, resources and competencies	1	2	3	4	5	Y	N	
	(iii) Exploitation of technology portfolio in new international market – for both acquisition and sales of IP	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(iv) Distinguish between ways to make incremental vs. radical innovation	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(v) Specific attention is paid to achieve cost reduction in present products	A good representation?					Drop this?		Substitute?
		1	2	3	4	5	Y	N	
	(vi) Others								

Appendix D

Summary of Findings From Opinion Survey of Experts and Practitioners

Components	Average Scores (out of 5)	Sub-Components	Average Scores (out of 5)	Comments
Management Decision for Technology Scanning	**4.15**	Antecedent role of market orientation	4.2	The word 'top management' should be used instead of management (C1). Rating of C1 will depend based on the industry (e.g. high-tech).
		Focus on technology	3.6	Culture was suggested as a parameter under C1, rated as 5;
		Voluntary participation of employees	4.2	The voluntary participation could be motivated through incentives / rewards.
		Organizational readiness (HR Policy, Processes, Tools)	4.1	More straight questions should be asked; Monitor supplier (site visit); Use of ERM/CRM.
Sources of Information	**3.75**	Internal sources (within organization)	3.4	C2-1, two ratings were done for this sub-component (2 - for small companies and 4 - for large companies). The average of 3 assumed as a single rating.
		Internal sources (within organizational network)	3.9	All four of these sub-components should be dropped, instead questions like individual sources (specific examples) could be asked.
		External sources (within national boundary)	3.7	

Components	**Average Scores (out of 5)**	**Sub-Components**	**Average Scores (out of 5)**	**Comments**
		External sources (outside national boundary)	4.0	
Responsiveness & Usage Level of Outcome	**3.9**	Perception of responsiveness in strategic matters	3.5	Dependent on the function of the industry (C3);
		Perception of responsiveness in operational matters	4.3	Responsiveness has two element - awareness element and Need element (C3).
		Evidence of using outcome in strategic matters	4.0	
		Evidence of using outcome in operational matters	4.2	
Level of Shared Sense of Future	**3.67**	Perception of shared sense (uniformity) among all employee groups within the organization	3.6	Dependent on the function of the industry (C4);
		Perception of shared sense (uniformity) among all stakeholders within firm's network	2.8	* Use organizational network instead of stakeholder * Shared sense within organizational networks is often short term.
		Anecdotal evidence in support or against this shared sense within organization	3.8	Get together all people to see the quality impacts on manufacturing, cost effectiveness, when something new is considered.
		Anecdotal evidence in support or against this shared sense within firm's network	3.1	Chief designer gets inputs from all groups; If a new market demand is identified, all parties (vendors, suppliers, local resources) get together.

Components	Average Scores (out of 5)	Sub-Components	Average Scores (out of 5)	Comments
Specific Goals Pursued Through Technology Scanning	**4.4**	Synergy with technological trends in the market	4.1	C5-1 through C5-5 could be considered as major components.
		Compatibility with firm's existing technologies, resources and competencies	4.1	
		Exploitation of technology portfolio in new international market – for both acquisition and sales of IP	3.9	This could be thought as a way to organic growth
		Distinguish between ways to make incremental vs. radical innovation	3	
		Specific attention is paid to achieve cost reduction in present products	4.2	This could be thought of as process change or improvement

Appendix E
Technology Scanning Survey Items and Associated Demographics Items

Survey Items

Please rate the following statements using your company as a reference

#	Statements to be rated	Do Not Agree At All — Strongly Agree
1	We help our customers anticipate developments in their markets.	1 2 3 4 5 6 7
2	We continuously try to discover additional needs of our customers of which they are unaware.	1 2 3 4 5 6 7
3	We incorporate solutions to unarticulated customer needs in our new products and services.	1 2 3 4 5 6 7
4	We brainstorm on how customers use our products and services.	1 2 3 4 5 6 7
5	We innovate even at the risk of making our own products obsolete.	1 2 3 4 5 6 7
6	We search for opportunities in areas where customers have a difficult time expressing their needs.	1 2 3 4 5 6 7
7	We work closely with lead users who try to recognize customer needs months or even years before the majority of the market may recognize them.	1 2 3 4 5 6 7
8	We extrapolate key trends to gain insight into what users in a current market will need in the future.	1 2 3 4 5 6 7
9	We constantly monitor our level of commitment and orientation to serving customer needs.	1 2 3 4 5 6 7

#	Statements to be rated	Do Not Agree At All						Strongly Agree
10	We freely communicate information about our successful and unsuccessful customer experiences across all business functions.	1	2	3	4	5	6	7
11	Our strategy for competitive advantage is based on our understanding of customers' needs.	1	2	3	4	5	6	7
12	We measure customer satisfaction systematically and frequently.	1	2	3	4	5	6	7
13	We are more customer-focused than our competitors.	1	2	3	4	5	6	7
14	We believe this business exists primarily to serve customers.	1	2	3	4	5	6	7
15	Data on customer satisfaction are disseminated at all levels in this business unit on a regular basis.	1	2	3	4	5	6	7
16	Our salespeople share information with each other about competitors.	1	2	3	4	5	6	7
17	We respond rapidly to the competitive actions of our rivals.	1	2	3	4	5	6	7
18	Top managers from each of our business units regularly visit customers.	1	2	3	4	5	6	7
19	Business functions within our organization are integrated to serve the target market needs.	1	2	3	4	5	6	7
20	Business strategies are driven by the goal of increasing customer value.	1	2	3	4	5	6	7
21	We pay close attention to after-sales service.	1	2	3	4	5	6	7
22	Top management regularly discusses competitors' strengths and weaknesses.	1	2	3	4	5	6	7
23	Our managers understand how employees can create value for our customers.	1	2	3	4	5	6	7
24	We share resources among business units.	1	2	3	4	5	6	7

#	Statements to be rated	Do Not Agree At All						Strongly Agree
25	Our company operates in an industry in which the technological sophistication of products is changing rapidly.	1	2	3	4	5	6	7
26	Technological change provides big opportunities in our industry.	1	2	3	4	5	6	7
27	It is very difficult to forecast where the technology in this market will be in five years time.	1	2	3	4	5	6	7
28	Many new product ideas have been made possible by technological advances in our industry.	1	2	3	4	5	6	7
29	Technological developments in our industry are relatively minor.	1	2	3	4	5	6	7
30	In this market, customers' preferences change quite a bit over time.	1	2	3	4	5	6	7
31	Customers in this market are very receptive to new-product ideas.	1	2	3	4	5	6	7
32	New customers tend to have product-related needs that are different from those of existing customers.	1	2	3	4	5	6	7
33	We cater to much the same customer base that we did in the past.	1	2	3	4	5	6	7
34	The market drives our search for new technological solutions.	1	2	3	4	5	6	7
35	Technology plays an important role in our approach to tackling an issue, whenever appropriate.	1	2	3	4	5	6	7
36	Our company encourages employees to explore new technological ideas voluntarily.	1	2	3	4	5	6	7
37	Our company makes policies, introduces processes and provides tools to enable employees to explore new technologies.	1	2	3	4	5	6	7

#	Statements to be rated	Do Not Agree At All						Strongly Agree
38	Our company uses the information available *within the organization* when searching for new technological solutions.	1	2	3	4	5	6	7
39	Our company uses the information available *among the members of the external network of the organization* when searching for new technological solutions.	1	2	3	4	5	6	7
40	Our company gathers information from global sources when searching for new technological solutions.	1	2	3	4	5	6	7
41	Our company responds well to any technology information that has a strategic implication.	1	2	3	4	5	6	7
42	Our company responds well to any technology information that has an operational implication.	1	2	3	4	5	6	7
43	Employees from different functional areas usually agree on the development path of our company's technology.	1	2	3	4	5	6	7
44	Our company usually makes an attempt to co-develop future development plans about its technology with other players in our business network.	1	2	3	4	5	6	7
45	Our company looks for synergy of company's product offerings with existing technological trends in the market.	1	2	3	4	5	6	7
46	Whenever possible, our company actively seeks to ensure compatibility with its existing technologies, resources and competencies while adopting a new technology.	1	2	3	4	5	6	7

#	Statements to be rated	Do Not Agree At All						Strongly Agree
47	Our company seeks to exploit new international markets through both acquisition and sale of intellectual property.	1	2	3	4	5	6	7
48	Our company consciously engages in both types of innovation, namely incremental and breakthrough innovation.	1	2	3	4	5	6	7
49	While considering new technological options, our company gives specific attention to achieve cost reduction in existing products.	1	2	3	4	5	6	7
50	The overall performance of our company met expectations last year.	1	2	3	4	5	6	7
51	The overall performance of our company last year exceeded that of our major competitors.	1	2	3	4	5	6	7
52	Top management was very satisfied with the overall performance of our company last year.	1	2	3	4	5	6	7
53	Our company successfully replaces the products that are being phased out.	1	2	3	4	5	6	7
54	Our company extends its core product offering through technologically new products.	1	2	3	4	5	6	7
55	Our company extends its core product offering through technologically improved products.	1	2	3	4	5	6	7
56	Our company often extends its product range outside the core product offering.	1	2	3	4	5	6	7
57	Our company develops environment-friendly products.	1	2	3	4	5	6	7
58	Market share of our products is improving.	1	2	3	4	5	6	7
59	Our company often breaks into new overseas market.	1	2	3	4	5	6	7

#	Statements to be rated	Do Not Agree At All / Strongly Agree
60	Our company often captures new domestic market segments.	1 2 3 4 5 6 7
61	Our company takes less time to develop a new product or a new component in comparison with our major competitors.	1 2 3 4 5 6 7
62	Average cost to develop a new product or a new component is less for our company in comparison with our major competitors.	1 2 3 4 5 6 7
63	Overall satisfaction of top management with the efficiency of new product development is very high.	1 2 3 4 5 6 7
64	Output of our company is best described as a product.	1 2 3 4 5 6 7

Demographics Items:

We would appreciate if you provide some information about yourself and your company. We assure you that demographic information is gathered for classification purposes only.

A1. Number of years of my total experience in the industry is:

☐ 1–2 years ☐ 3-5 years ☐ 6-10 years ☐ over 10 years

A2. My current job title:

____

A3. Number of years in current job:

☐ 1–2 years ☐ 3-5 years ☐ 6-10 years ☐ over 10 years

A4. Current major field of work:

☐ Marketing ☐ R&D ☐ General Mgmt ☐ Other

A5. Number of years in major field of work:

☐ 1–2 years ☐ 3-5 years ☐ 6-10 years ☐ over 10 years

A6. My highest formal qualification is:

☐ No formal qualification ☐ High School

☐ College Diploma ☐ Undergraduate University Degree

☐ Graduate Degree (Masters, PhD) ☐ Postgraduate Diploma

<u>Please tell us about your company</u>:

B1. Approximately, the number of employees in our company is:

☐ Less than 10 ☐ 11 - 50 ☐ 51 – 100 ☐ 101 – 250

☐ 251 - 500 ☐ 501 - 1000 ☐ over 1000

B2. Approximately our annual sales are:

☐ $1 - $99,999 ☐ $100,000 - $199,999

☐ $200,000 – $499,999 ☐ $500,000 - $999,999

☐ $1,000,000 – $4,999,999 ☐ $5,000,000 - $9,999,999

☐ $10,000,000 – 24,999,999 ☐ $25,000,000 - $49,999,999

☐ $50,000,000 +

B3. Sales of our company come from:

☐ Product Only ☐ Service Only ☐ Both (If both ___% Product & ___% Service)

B4. The following best describes the main industry in which our company operates: (Check as many as applicable)

☐ Automotive & Transportation
☐ Clothing and Textile
☐ Consumer Electronics
☐ Other Consumer Products
☐ Agriculture Related
☐ Forestry Related
☐ Fishing and Hunting
☐ Energy
☐ Environmental Technologies
☐ Other, specify ________________________

☐ Industrial Products (Chemicals, Plastics, etc)
☐ Information Technologies
☐ Software
☐ Telecommunications
☐ Life Sciences
☐ Marine
☐ Nanotechnologies
☐ Resource and Resource Processing Industries
☐ Service Industries (Professional, training, etc)

C1. Geographical location(s) of other operations (other than your location) of your company.

Our company has a single location where I work ☐Yes ☐No

If No, please indicate where the other locations are:

a. My province / territory	☐ Yes	☐ No
b. In the rest of Canada	☐ Yes	☐ No
c. USA	☐ Yes	☐ No
d. Mexico	☐ Yes	☐ No
e. Europe	☐ Yes	☐ No
f. Asia Pacific	☐ Yes	☐ No
g. All other countries	☐ Yes	☐ No

C2. The head office of our company is located in:

☐ My province / territory
☐ Canada
☐ USA
☐ Mexico
☐ Europe
☐ Asia Pacific
☐ All other countries

D1. Please estimate (as best as you can) the percentage of your full-time employees in your company in 2007 who:

a. Have a university degree _____%
b. Have a college / technical institute diploma _____%

D2. The percentage of the full-time employees in our company in 2007 who were involved in R&D was _____%

D3. The percentage of full-time employees in our company in 2007 who are involved in marketing, sales or client services was _____%

E1. During the last three years, our company introduced:

New or significantly improved products	☐ Yes	☐ No
New or significantly improved services	☐ Yes	☐ No

E2. During last three years, our company introduced many new or significantly improved products or services onto the market:

____ Number of new or significantly improved products, if any
____ Number of new or significantly improved services, if any

E3. These products or services innovations during last three years were developed by:

☐ Mainly our company

☐ Our company together with other firms or organizations

☐ Mainly other firms or organizations

F1. Our company introduced new or significantly improved products or services onto the market before our competitors during the three years:

☐ Yes

☐ No

F2. If yes, please estimate (as best as you can) the percentage of revenue in 2007 from these first-to-the-market products or services innovations that were introduced during last three years ________%

G1. Our company introduced new or significantly improved products or services onto the market that were already available from our competitors, during the three years:

☐ Yes

☐ No

G2. If yes, please estimate (as best as you can) the percentage of revenue in 2007 from these already-on-the-market products or services innovations that were introduced during last three years.

_________%

H1. On average, it takes for our company to develop a new or significantly improved product or service: _____ Year(s) _______ Month(s)

H2. During the last three years, new or significantly improved products or services introduced by our company:

a. A first in your province / territory	☐ Yes	☐ No	☐ Do not know
b. A first in Canada	☐ Yes	☐ No	☐ Do not know
c. A first in North America	☐ Yes	☐ No	☐ Do not know
d. A world first	☐ Yes	☐ No	☐ Do not know

I1. During the last three years, our company acquired licenses from other firms or organizations:

☐ Yes

☐ No

I2. If yes, please indicate the source of licenses:

☐ A Canadian firm

☐ A foreign firm

☐ A Canadian university

☐ A Canadian hospital

☐ A Canadian federal government lab

☐ A provincial / territorial government lab

☐ _______________other, please specify

I3. During the last three years, our company applied for a patent:

☐ Yes

☐ No

J. An organizational innovation is the implementation of new or significant changes in the structure or management methods of a company that are intended to improve its use of knowledge, the quality of goods or services, or the efficiency of work flows. During the last three years, our company introduced:

J1. New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills ☐ Yes ☐ No

J2. Major changes to the organization of work within our company, such as changes in the management structure or integrating different departments or activities ☐ Yes ☐ No

J3. New or significant changes in external relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting ☐ Yes ☐ No

K. A marketing innovation is the implementation of new or significantly improved designs or sales methods to increase the appeal of goods or services or to enter new markets. During the last three years, our company introduced:

K1. Significant changes to the design or packaging of a good or service ☐Yes ☐ No

K2. New or significantly changed sales or distribution methods, such as internet sales, franchising, direct sales or distribution licenses ☐Yes ☐ No

(This is the end of the survey)

Appendix F
Analysis of Late-Responder Bias and Demographic Details

Creswell (1994) suggested a method of testing non-response bias (also known as wave analysis) by identifying those who responded later in the process, who are likely to have similar characteristics to those of non-responders. Armstrong and Overton (1977) also used a similar method to proxy for non-responders. The main reasoning behind this method is that respondents who took more time to respond to the survey are more likely to have the properties of non-responders. This analysis attempted to find out whether there are any systematic differences between early-responders and late-responders. Since a reminder was sent during the current survey administration to improve the response rate, those who responded after the reminder were identified as likely non-responders. Of 467 total respondents, 204 are identified as late respondents while the remaining 263 are early respondents.

Table F-1 and Table F-2 highlight the number of employees in the surveyed firms and annual sales of the firms. In both cases, all respondents' numbers are divided into early and late respondents to illustrate their relative differences. No systematic differences were found between the two groups. These two tables also compare the percent of respondents in each category with the percent of firms in those categories that were present in the Canadian Capabilities Database (CCC 2008).

Table F-1 Number of Employees of the Firms

Number of Employees	Firm Population	All Respondents[5]		Early-Respondents		Late-Respondents[3,4]	
		Number	%	Number	%	Actual Number	Projected Number[2]
Less than 10	3270	138	30	76	29	62	60
11 – 50	5033	166	36	102	39	64	73
51 – 100	1567	63	14	37	14	26	28
101 – 250	1117	46	10	20	8	26	20
251 – 500	405	13	3	6	2	7	6
501 – 1000	204	11	2	6	2	5	5
1000+	169	25	5	14	5	11	11
		462[1]		261		201	

[1] Excluding 5 blank fields

[2]Total to Late Respondents Ratio is (204/467= 0.4368)

[3] Late respondents are not a different group than all respondents, at α = 0.05 level (corresponding Kolmogorov-Smirnov test statistic = 0.0381534)

[4]Late respondents are not a different group than early respondent, at α = 0.05 level (corresponding Kolmogorov-Smirnov test statistic = 0.0675359)

[5] All respondents are not a different group than population, at α = 0.05 level (corresponding Kolmogorov-Smirnov test statistic = 0.0477287)

Table F-3 shows the number of firms in different industry groups and their corresponding numbers in the late-responder category. The figures indicate that there is no significant difference in the actual number of late responders and projected numbers that were expected on a proportional basis. Also, no significant differences were found among all respondents, early respondent and late respondents groups.

Table F-2 Annual Sales of the Firms

Annual Sales	Firm Population	All Respondents[5]		Early Respondent		Late Respondent[3,4]	
		Number	%	Number	%	Actual Number	Projected Number[2]
$1 - $99,999	247	33	7	14	5.5	19	14
$100,000 - $199,999	227	13	3	9	3.5	4	6
$200,000 - $499,999	613	35	8	18	7	17	15
$500,000 - $999,999	845	43	10	22	8.6	21	19
$1,000,000 - $4,999,999	3173	121	27	67	26	54	53
$5,000,000 - $9,999,999	1254	59	13	40	15.7	19	26
$10,000,000 - 24,999,999	1275	53	12	31	12	22	23
$25,000,000 - $49,999,999	591	28	6	17	6.7	11	12
$50,000,000 +	765	67	15	36	14	31	29
Total		452[1]		254		198	

[1] Excluding 15 blank fields

[2] Late Respondents ratio is (204/467= 0.4368)

[3] Late respondents are not a different group than all respondents, at $\alpha = 0.05$ level (Kolmogorov-Smirnov test statistic = 0.0387727)

[4] Late respondents are not a different group than early respondent, at $\alpha = 0.05$ level (corresponding Kolmogorov-Smirnov test statistic = 0.0689971)

[5] All respondents are not a different group than population, at $\alpha = 0.05$ level (Kolmogorov-Smirnov test statistic = 0.0631355)

Table F-3 Industry Groups of Firms (n = 467)

Industry Sectors	All Respondents		Early Respondents		Late Respondents[3,4]	
	Number	% of Sample	Number	%	Actual Number	Projected number[2]
Automotive & Transportation	73	16	42		31	32
Clothing and Textile	21	4	7		14	9
Consumer Electronics	18	4	8		10	8
Other Consumer Products	70	15	35		35	31
Agriculture Related	44	9	23		21	19
Forestry Related	39	8	26		13	17
Fishing and Hunting	4	1	1		3	2
Energy	66	14	33		33	29
Environmental Technologies	56	12	32		24	24
Industrial Products (e.g., Chemicals, Plastics)	70	15	39		31	31
Information Technologies	30	6	16		14	13
Software	34	7	23		11	15
Telecommunications	21	4	11		10	9
Life Sciences	21	4	8		13	9
Marine	16	3	10		6	7
Nanotechnologies	11	2	6		5	5
Resource and Resource Processing Industries	25	5	13		12	11
Service Industries (Professional, training, etc)	11	2	6		5	5
Total	690[1]					

[1] Total value greater than sample size reflects multiple selections by respondents

[2] Late Respondents ratio is (204/467= 0.4368)

[3] Late respondents are not a different group than all respondents, at α = 0.05 level (Kolmogorov-Smirnov test statistic = 0.0234642)

[4] Late respondents are not a different group than early respondents, at α = 0.05 level (Kolmogorov-Smirnov test statistic = 0.0437638)

Table F-4 Descriptive Statistics of Early-Respondents and Late-Respondents

ResponseRem		TSC 1	TSC 2	TSC 3	TSC 4	TSC 5	TSC 6	TSC 7	TSC 8	TSC 9	TSC 10	TSC 11	TSC 12	TSC 13	TSC 14	TSC 15	TSC 16
0	Mean	5.38	5.55	5.42	4.96	4.94	5.10	5.44	5.25	5.28	4.71	4.08	5.03	5.66	3.45	4.92	5.49
	N	263	262	262	260	262	262	263	263	262	259	260	260	262	260	260	263
	Std. Deviation	1.44	1.26	1.35	1.47	1.53	1.30	1.40	1.24	1.20	1.34	1.72	1.36	1.24	1.88	1.49	1.25
1	Mean	5.09	5.37	5.14	4.74	4.79	5.05	5.40	5.10	5.12	4.71	4.24	4.97	5.32	3.42	4.65	5.54
	N	204	203	203	201	203	201	202	204	204	202	202	201	201	200	203	204
	Std. Deviation	1.41	1.34	1.44	1.48	1.50	1.50	1.36	1.32	1.25	1.33	1.76	1.43	1.34	2.00	1.66	1.25
Total	Mean	5.25	5.47	5.30	4.87	4.88	5.08	5.42	5.18	5.21	4.71	4.15	5.00	5.51	3.43	4.80	5.52
	N	467	465	465	461	465	463	465	467	466	461	462	461	463	460	463	467
	Std. Deviation	1.43	1.29	1.40	1.48	1.52	1.39	1.38	1.28	1.22	1.33	1.74	1.39	1.30	1.93	1.57	1.25

Table F-5 ANOVA Result of Technology-Scanning Items for Late-Respondent Bias

			df	F	Sig.
TSC1 * RespRem	Between Groups	(Combined)	1	4.927	.027
		Within Groups	465		
		Total	466		
TSC2 * RespRem	Between Groups	(Combined)	1	2.116	.146
		Within Groups	463		
		Total	464		
TSC3 * RespRem	Between Groups	(Combined)	1	4.379	.037
		Within Groups	463		
		Total	464		
TSC4 * RespRem	Between Groups	(Combined)	1	2.514	.114
		Within Groups	459		
		Total	460		
TSC5 * RespRem	Between Groups	(Combined)	1	1.107	.293
		Within Groups	463		
		Total	464		
TSC6 * RespRem	Between Groups	(Combined)	1	.115	.734
		Within Groups	461		
		Total	462		

			df	F	Sig.
TSC7 * RespRem	Between Groups	(Combined)	1	.142	.707
		Within Groups	463		
		Total	464		
TSC8 * RespRem	Between Groups	(Combined)	1	1.640	.201
		Within Groups	465		
		Total	466		
TSC9 * RespRem	Between Groups	(Combined)	1	2.070	.151
		Within Groups	464		
		Total	465		
TSC10 * RespRem	Between Groups	(Combined)	1	.000	.984
		Within Groups	459		
		Total	460		
TSC11* RespRem	Between Groups	(Combined)	1	.965	.326
		Within Groups	460		
		Total	461		
TSC12 * RespRem	Between Groups	(Combined)	1	.222	.638
		Within Groups	459		
		Total	460		

			df	F	Sig.
TSC13 * RespRem	Between Groups	(Combined)	1	7.956	.005
		Within Groups	461		
		Total	462		
TSC14 * RespRem	Between Groups	(Combined)	1	.037	.848
		Within Groups	458		
		Total	459		
TSC15 * RespRem	Between Groups	(Combined)	1	3.378	.067
		Within Groups	461		
		Total	462		
TSC16 * RespRem	Between Groups	(Combined)	1	.181	.671
		Within Groups	465		
		Total	466		

Tables F-4 shows descriptive statistics of early-respondents and late-respondents and Table F-5 shows ANOVA result of technology-scanning items for late-respondent bias. Examining the ANOVA result of TechScan items for late-respondent bias in Table F-5, the following items are found to be potentially biased: TSC01, TSC03, TSC13 and TSC15. For the sake of getting an alternate opinion, I ran another factor analysis on the TechScan items excluding these four suspects. When 'Eigenvalue is greater than or equal to one' criterion was strictly applied, two factors were found. In this case, items TSC10 and TSC11 cross-loaded into both factors and items TSC14 and TSC16 had insignificant loadings; hence these were dropped. One of these two factors was exactly same as before and it was TechRespond factor in the original findings with the same two items and it explained 4.7% of the variance. The remaining items loaded into the other factor that explained 33.3% of the variance. These items, as a group, were closer to those in the TechInfo factor originally reported with some changes. In essence, these two factors could be named as TechInfoGather and TechInfoResp. The detailed items of these two factors are listed in Table F-6. TechInfoGather retains four items (TSC02, TSC04, TSC05, TSC07) of the original TechInfo factor in addition to one item (TSC12) from original TechAlign factor and one item (TSC06) that was dropped during the original analysis. TechInfoResp factor is exactly the same as TechRespond factor in the original analysis with the same two items. It was renamed for the purpose of making a distinction in the stage of analysis only.

Although two factor model seemed plausible, a closer look at the Scree plot suggested that there might be two additional factors that were being suppressed as a result of strict application of 'Eigenvalue is greater than or equal to one' criterion. So, a second factor analysis was performed allowing for four possible factors and the item loadings are shown in Table F-7. As evident from Table F-7, model structure again changes from the original one. There was however strong similarity even with the exclusion of four items from the construct at the beginning. One of the earlier factors, which had six items (i.e., TechInfo), splints into two new factors and these are named as TechInfo1 and TechInfo2. All three items of TechInfo1 (TSC02, TSC04 and TSC05) are part of the original TechInfo factor. One of the two items of TechInfo2 (TSC07) is also from the original TechInfo factor and the other item (TSC06) was originally dropped due to cross-loading. The TechRespNew factor was exactly same as the original factor of TechRespond with the same two items. There are two items in TechAlignNew both of which are part of original TechAlign factor. The factor with least variance in the original analysis (i.e., TechExploit) has disappeared in new analysis. The reason for this disappearance could be attributed to the fact that it had only two items (TSC14 and TSC15) to begin with and one of its items (TSC15) was excluded at the beginning of factor analysis to account for potential late-respondent bias. The remaining item (TSC14) was dropped in this round of factor analysis due to insignificant loading.

To conclude the discussion on the effect of late-respondent bias, it is important to note that the literature is split in using late-responders as a proxy for non-responders. This disagreement in the literature was also evident within the examination committee. Moreover, after careful observation of the late-respondent analysis, the changes suggested in the model of TechScan scale by the new analysis are incremental. If the two-factor model were to be used to account for the late-response bias, it suggests technology-scanning capability as two dimensional construct. One dimension is concerned with collection of technology-related information and the other dimension is concerned with responding to the collected technology-related information. If the 4-factors model were to be used to account for late-response bias, the factors broadly represent a structure that is not far from the original model. Few things to note among these three competing models – the original model reported in the text compared with two alternate models that account for late-respondent bias in varying degree:

1. All three models suggest that TSC10 and TSC16 items should be dropped.
2. The TechRespond factor in the original analysis stays intact in two other analyses.
3. The 2-factors model (TechInfoGather and TechInfoResp) has a conceptual clarity as it matches with Sense-and-Respond framework. However, this factor suggest dropping of two important items (TSC11 & TSC14) that account for coordination within technological activity within the firm and exploitation of existing technological portfolio. Indeed, dropping of these two items are partially responsible for the disappearance of TechAlign and TechExploit factors that were reported in original analysis.
4. The new 4-factors model (TechRespNew, TechInfo1, TechAlignNew & TechInfo2) is conceptually closer to the original 4-factors model (TechInfo, TechAlign, TechRespond & TechExploit). This new analysis however suggested dropping of an additional item that account for exploitation of existing technological portfolio. With the emergence and popularity of open innovation practices, exploitation of existing technologies through out-licensing and partnering is an important phenomenon. Moreover, the splitting of technological information gathering also does not add more value while it loses the exploitation aspect of technology-scanning activities.

Table F-6 Examining Effects of Late-Responder Bias in TechScan Scale (2-factors model)

Items	**Item Loadings**	**Factor Names and Corresponding Cronbach's Alpha, % Variance Explained and Eigenvalues**
TSC02: Technology plays an important role in our approach to tackling an issue, when appropriate.	0.496	Factor 1: TechInfoGather Cronbach's Alpha = Eigenvalue = % Variance Explained =
TSC04: Policies, processes and tools to enable employees to explore new technologies.	0.665	
TSC05: Uses the information available within the organization.	0.563	
TSC06 : Uses information from organizations in external network when searching for new technological solutions	0.650	
TSC07: Gathers information from global sources when searching for new technological solutions.	0.637	
TSC12: Looks for synergy of product offerings with existing technological trends in the market.	0.469	
TSC08: Responds well to any technology information that has a strategic implication.	0.891	Factor 2: TechInfoResp Cronbach's Alpha = Eigenvalue = % Variance Explained =
TSC09: Responds well to any technology information that has an operational implication.	0.861	
TSC10: Employees from different functional areas usually agree on technology development path.	This item was dropped for cross-loading into multiple factors (less than 0.15 difference)	
TSC11: Makes an attempt to co-develop development plans about its technology with other players in business network.	This item was dropped for cross-loading into multiple factors (less than 0.15 difference)	
TSC14: Seeks to exploit new international markets through acquisition and sale of intellectual property.	This item was dropped due to insignificant loadings (less than 0.32 in any factor)	
TSC16: Gives specific attention to achieve cost reduction in existing products.	This item was dropped due to insignificant loadings (less than 0.32 in any factor)	

Table F-7 Examining Effects of Late-Responder Bias in TechScan Scale (4-factors model)

Items	**Item Loadings**	**Factor Names and Corresponding Cronbach's Alpha, % Variance Explained and Eigenvalues**
TSC08: Responds well to any technology information that has a strategic implication.	0.804	Factor 1: TechRespNew Cronbach's Alpha = 0.854 Eigenvalue = 4.533 % Variance Explained = 33.932
TSC09: Responds well to any technology information that has an operational implication.	0.959	
TSC02: Technology plays an important role in our approach to tackling an issue, when appropriate.	0.675	Factor 2:TechInfo1 Cronbach's Alpha = 0.669 Eigenvalue = 1.107 % Variance Explained = 5.181
TSC04: Policies, processes and tools to enable employees to explore new technologies.	0.782	
TSC05: Uses the information available within the organization.	0.477	
TSC11: Makes an attempt to co-develop future development plans about its technology with other players in business network.	0.903	Factor 3: TechAlignNew Cronbach's Alpha = 0.593 Eigenvalue = 0.987 % Variance Explained = 5.012
TSC12: Looks for synergy of product offerings with existing technological trends in the market.	0.466	
TSC6 : Uses information from organizations in external network when searching for new technological solutions	0.747	Factor 4: TechInfo2 Cronbach's Alpha = 0.678 Eigenvalue = 0.946 % Variance Explained = 2.59
TSC07: Gathers information from global sources when searching for new technological solutions.	0.610	
TSC10: Employees from different functional areas usually agree on technology development path.	This item was dropped due to insignificant loadings (less than 0.32 in any factor)	
TSC14: Seeks to exploit new international markets through acquisition and sale of intellectual property.	This item was dropped due to insignificant loadings (less than 0.32 in any factor)	
TSC16: Gives specific attention to achieve cost reduction in existing products.	This item was dropped due to insignificant loadings (less than 0.32 in any factor)	

Appendix G
Descriptive Statistics for Initial Sixteen Items for TechScan Scale

	Mean	Std. Deviation	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TSC1	5.27	1.419	74.59	171.322	0.487	0.326	0.875
TSC2	5.48	1.305	74.38	169.903	0.583	0.457	0.871
TSC3	5.3	1.398	74.56	164.534	0.696	0.638	0.866
TSC4	4.88	1.47	74.97	165.195	0.637	0.575	0.868
TSC5	4.87	1.537	74.99	172.768	0.403	0.25	0.878
TSC6	5.1	1.382	74.76	170.687	0.522	0.353	0.873
TSC7	5.43	1.37	74.43	167.977	0.608	0.441	0.87
TSC8	5.19	1.28	74.67	167.561	0.671	0.643	0.868
TSC9	5.22	1.232	74.64	171.207	0.58	0.578	0.871
TSC10	4.71	1.34	75.15	170.402	0.55	0.361	0.872
TSC11	4.16	1.754	75.7	168.133	0.444	0.302	0.878
TSC12	5	1.409	74.86	166.92	0.618	0.526	0.869
TSC13	5.51	1.312	74.35	170.292	0.567	0.473	0.872
TSC14	3.44	1.925	76.42	171.16	0.329	0.238	0.885
TSC15	4.81	1.566	75.05	165.602	0.58	0.407	0.871
TSC16	5.5	1.272	74.36	179.834	0.293	0.141	0.882

Appendix H

Inter-Item Correlation Matrix for TechScan Scale

	TSC1	TSC2	TSC3	TSC4	TSC5	TSC6	TSC7	TSC8	TSC9	TSC10	TSC11	TSC12	TSC13	TSC14	TSC15	TSC16
TSC1	1	0.513	0.383	0.348	0.182	0.247	0.283	0.353	0.325	0.261	0.206	0.339	0.299	0.204	0.34	0.228
TSC2	0.513	1	0.565	0.519	0.306	0.271	0.373	0.421	0.355	0.324	0.246	0.337	0.316	0.176	0.411	0.191
TSC3	0.383	0.565	1	0.728	0.39	0.403	0.515	0.501	0.431	0.438	0.284	0.451	0.375	0.172	0.428	0.255
TSC4	0.348	0.519	0.728	1	0.388	0.387	0.466	0.429	0.405	0.381	0.266	0.394	0.341	0.158	0.407	0.202
TSC5	0.182	0.306	0.39	0.388	1	0.322	0.299	0.259	0.182	0.312	0.125	0.244	0.321	0.101	0.251	0.101
TSC6	0.247	0.271	0.403	0.387	0.322	1	0.514	0.338	0.322	0.313	0.271	0.391	0.358	0.163	0.29	0.21
TSC7	0.283	0.373	0.515	0.466	0.299	0.514	1	0.466	0.384	0.355	0.248	0.38	0.335	0.261	0.417	0.239
TSC8	0.353	0.421	0.501	0.429	0.259	0.338	0.466	1	0.739	0.473	0.339	0.465	0.445	0.236	0.464	0.19
TSC9	0.325	0.355	0.431	0.405	0.182	0.322	0.384	0.739	1	0.445	0.275	0.367	0.401	0.155	0.363	0.224
TSC10	0.261	0.324	0.438	0.381	0.312	0.313	0.355	0.473	0.445	1	0.326	0.329	0.424	0.19	0.295	0.193
TSC11	0.206	0.246	0.284	0.266	0.125	0.271	0.248	0.339	0.275	0.326	1	0.484	0.311	0.283	0.32	0.088
TSC12	0.339	0.337	0.451	0.394	0.244	0.391	0.38	0.465	0.367	0.329	0.484	1	0.601	0.258	0.371	0.175
TSC13	0.299	0.316	0.375	0.341	0.321	0.358	0.335	0.445	0.401	0.424	0.311	0.601	1	0.116	0.333	0.252
TSC14	0.204	0.176	0.172	0.158	0.101	0.163	0.261	0.236	0.155	0.19	0.283	0.258	0.116	1	0.414	0.13
TSC15	0.34	0.411	0.428	0.407	0.251	0.29	0.417	0.464	0.363	0.295	0.32	0.371	0.333	0.414	1	0.105
TSC16	0.228	0.191	0.255	0.202	0.101	0.21	0.239	0.19	0.224	0.193	0.088	0.175	0.252	0.13	0.105	1

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