INCREMENTAL INNOVATION AND RADICAL INNOVATION: THE IMPACTS OF HUMAN, STRUCTURAL, SOCIAL, AND RELATIONAL CAPITAL ELEMENTS

By

Jung Young Lee

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Operations and Sourcing Management

2011

ABSTRACT

INCREMENTAL INNOVATION AND RADICAL INNOVATION: THE IMPACTS OF HUMAN, STRUCTURAL, SOCIAL, AND RELATIONAL CAPITAL ELEMENTS

By

Jung Young Lee

Intellectual capital collectively refers to knowledge resources stored in various forms within organizations. Since intangible resources, instead of tangible resources, actually contribute to generating a competitive advantage, the recognition of the importance of intellectual capital has been growing. Nevertheless, organizations and researchers experience difficulties in identifying and managing intellectual capital to increase the performance of different types of innovation projects. Responding to these challenges, this dissertation first theoretically elaborates four key dimensions of intellectual capital, including human capital, structural capital, social capital and relational capital. Second, based on this framework, key elements of intellectual capital are identified. Third, using survey data from manufacturing companies in the U.S., this dissertation empirically examines how intellectual capital elements influence the performance of incremental innovation projects and radical innovation projects differently. The results suggest that social capital and relational capital elements should be carefully managed in response to different types of innovation projects.

ACKNOWLEDGMENTS

This dissertation would not have come into existence without the generous support and encouragement of many people.

First, I would like to express my profound gratitude to my advisor, Dr. Morgan Swink, who gave me the opportunity to start my doctoral journey at Michigan State University and has always encouraged me to be a good researcher. His rigorous supervision and insight improved the quality of my dissertation and other projects significantly. The last four years working with him and learning from him truly blessed my Ph.D. life.

I am also heartily thankful to my committee members. Dr. Roger Calantone has taught me how to view and evaluate my approach to solve research problems more critically. His endlessly energetic research activities always inspired me. Dr. Gary Ragatz provided me with helpful suggestions on preliminary research design and survey instrument. Dr. Sriram Narayanan's thoughtful criticism and attention to details contributed to the strength of this dissertation from top to bottom. Dr. David Closs reminded me of the importance of translating academic implications to managerial implications. Having this committee for my dissertation was a great privilege.

It is difficult to overstate my gratitude to many outstanding professors at MSU for showing me how to think as a researcher and how to teach students as a mentor: Dr. Ram Narasimhan, Dr. Srinivas Talluri, Dr.Carol Prahinski, and Dr.Steven Melnyk.

I am indebted to many dearest friends for providing a warm environment to endure all the hard moments in the journey of getting a Ph.D. degree: Rebecca Flyod, Ravi Srinivasan, Jieun

Lee, Linlin Chai, Billur Akdeniz, Bob Viswanathan, Matthias Spitzmueller, Delvon Parker, Jeannette Mena, and Evelyne Vanpoucke.

Finally, I want to dedicate this dissertation to my parents, Jong Yang Lee and Suk Hee Yoon, my younger brother, Chan Young Lee, and my soul mate, Da Woon Jung for their support and understanding during the long years of my doctoral studies.

TABLE OF CONTETS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 Research Background

The analysis of corporate evolution with the 200 largest US manufacturing companies throughout the 20th century has shown that only 28 firms have continued to exist (Louca and Mendonca, 2002). In the 21st century, companies face a more fierce and dynamic environment which is characterized by the combination of globalization, advanced technology, shortened product-life cycles, and network partnerships (Cardinal, 2001; Hayes, Pisano, Upton, and Wheelwright, 2005). Under the new world economy, the dominant managerial practices or tools with traditional strategic focus (e.g., cost cutting, benchmarking, reengineering, etc.) became ineffective and insufficient to generate competitive advantage (Hayes et al., 2005; Marr, 2005; Teece, 2007). This raised the fundamental question - what do organizations do to survive?

One research stream suggests that firms must adapt to environmental changes by harnessing dynamic capabilities: the ability of a firm to gain, integrate, and reconfigure resources within and outside of the firm (Eisenhardt and Martin, 2000; Teece, Pisano, and Shuen, 1997). Innovation is a practical way to develop the dynamic capabilities by driving continuous changes in products and processes for competitive advantage over time (Danneels, 2002; Eisenhardt and Martin, 2000; Rothaermel and Hess, 2007; Teece, 2007; Verona and Ravasi, 2003). Incremental innovation refers to improving the efficiency of current products and processes, which can generate short term profit. But, in order to ensure long term profit, a firm also needs to initiate radical innovation which entails exploring novel technologies and opportunities to develop new markets. Consequently, many researchers have investigated mechanisms to foster both incremental innovation and radical innovation, putting the same amount of emphasis on each of them (Benner and Tushman, 2003; Jansen, Bosch, and Volberda, 2006; March, 1991; Naveh and Erez, 2004).

In order to explain a firm's survival, another research stream focuses on intangible resources, including skills and knowledge of employees, databases, information technology, operating processes, customer relationship, brand, and cultures (Andriessen, 2004; Kaplan and Norton, 2001). In the past, capitalists' main focus was tangible resources such as land, machines and factory. However, as competition became increasingly global and intense, a firm needs to be unique (Andriessen, 2004). The uniqueness does derive from intangible resources that its competitors cannot easily imitate, not from tangible resources. Indeed, recent accounting statistics have shown that the relationship between the book value and market value of a firm has been constantly reduced (Cezair, 2008). This emphasizes the role of the residuals, which are intangible assets that traditional accounting methods cannot easily capture in addressing the success of the firm. Knowledge-based theories, a derivative of resourced-based view of the firm, assert that knowledge is the key intangible resource necessary for creating and sustaining competitive advantage due to its nature of non-substitutable, path-dependent, and difficult-to-imitate (Alavi and Leidner, 2001; Argote, McEvily, and Reagans, 2003; Nonaka, 1994; Zack, 1999).

Intellectual capital, broadly defined as a diverse set of knowledge-related resources that can be converted into value, is a topic of increasing importance for managers and researchers who are interested in how firms derive their profits from innovation via the commercialization of knowledge (Edvinsson and Sullivan, 1996; Marr, 2005; Stewart, 1997). There is a strong relationship between knowledge and innovation. Knowledge enables generating innovation in such a way that both the application of novel pieces of knowledge and a novel combination of existing knowledge lead to innovation (Fischer, 2006). At the same time, innovation activities can create a new set of knowledge for future innovation, which cannot be otherwise obtained (Choo, Linderman, and Schroeder, 2007; Eisenhardt and Martin, 2000; Lev, 2001). In this perspective, the success of an innovation project depends on whether or not a project team can orchestrate and develop available knowledge stocks in response to environmental changes (Teece, 2007). More specifically, how to acquire, distribute, and utilize knowledge becomes critical in the innovation project (Cohen and Levinthal, 1990; Drucker, 1993; Huber, 1991; Lane, Koka, and Pathak, 2006; Nonaka, 1994; Slater and Narver, 1995; Tu, Vonderembse, Ragu-Nathan, and Sharkey, 2006). Each project team's approach to knowledge management is unique due to its distinctive aspects of intellectual capital: human capital (e.g., know-how, skills of employees); structural capital (e.g., intellectual property, patents, routines, processes); social capital (e.g., culture, informal interactions); and relational capital (e.g., relationship with external partners such as suppliers and customers) (Fischer, 2006; Marr, 2005; Subramaniam and Youndt, 2005).

Given the huge importance of innovation and knowledge as a source of competitive advantage, various academic disciplines have proposed the positive relationship between intellectual capital and innovation performance (Grindley and Teece, 1997; Menor, Kristal, and Rosenzweig, 2007; Subramaniam and Youndt, 2005). Nevertheless, executives still suffer from inefficiency in the utilization of intellectual capital (Edvinsson and Sullivan, 1996), as can be seen from a survey conducted by the Economist and Accenture in 2003 (Molnar, 2004). Almost every executive around the world who responded to the survey reported that managing intangible assets is the primary source of competitive advantage. Nevertheless, 95 percent of the 120 executives said that they do not have a robust system to measure intellectual capital and the generated performance. This contradiction reveals that theory and research have not been successful in addressing how to recognize the existence of intellectual capital within organizations and the impact of the knowledge-related resources on measurable performances. Pondering theses problems, this dissertation asks meaningful but understudied questions. How to conceptualize the multidimensional and complex concept of intellectual capital? Which intellectual capital elements are necessary for different innovation projects? How do the intellectual capital elements interplay each other to influence the performance of innovation projects?

1.2 Research Objectives

The purpose of this dissertation is threefold. First, I attempt to refine the concept of intellectual capital further by synthesizing related discussions from various academic fields. Current literature on intellectual capital asserts that the concept has a multidimensional and multidisciplinary nature (Menor et al., 2007; Subramaniam and Youndt, 2005). However, researchers appear to have no consensus on which and how many dimensions should be measured (Marr, 2005; Molnar, 2004). This dissertation captures four key subdimensions of intellectual capital from an extensive literature review: human capital, structural capital, social capital, and relational capital. Based on this framework, I identify a diverse set of intellectual capital elements that innovation project teams can own and utilize.

Second, this dissertation attempts to figure out different sets of specific intellectual capital elements for different innovation projects. Intellectual capital is assumed to be generally beneficial to innovation. However, radical innovation projects and incremental innovation projects may draw upon the knowledge resources in considerably different ways (Subramaniam and Youndt, 2005). Incremental innovation projects depend on prevailing knowledge to extend existing products and services for current markets, while radical innovation projects pursue new knowledge to serve emerging markets (Benner and Tushman, 2003; Jansen et al., 2006). While previous research has asserted that radical innovation projects should be differently managed than incremental innovation projects, empirical studies have showed inconsistent support (Cardinal, 2001; Ettlie, Bridges, and O'Keefe, 1984; Jansen et al., 2006). Therefore, it is clear that much more remains to be understood about how intellectual capital elements differently influence the exploratory and exploitative innovation.

Third, I explore the underlying interrelationships among intellectual capital elements. Prior research on innovation has examined various contingencies in developing innovation capabilities via conducting innovation projects. Exemplary moderators are type of organization, size of organization, stage of adoption, the scope of innovation, and environmental dynamism (Damanpour, 1991). Unlike previous studies, this dissertation intends to develop and test theories that explain interactions among the elements of intellectual capital in greater detail. A key assumption is that a knowledge resource can be combined with other knowledge resources to produce more value. Yet, there has been lack of both theoretical and empirical endeavors to delve into interactions among intellectual capital elements to increase the performance of innovation projects with different degrees of change.

1.3 Research Contributions

Pursuing the three research objectives, this dissertation will generate theoretical as well as managerial implications. Taken together, this study can advance our understanding as to the management of knowledge-related resources.

For the theoretical contribution, this dissertation suggests a conceptual framework to combine literature on intellectual capital across various academic disciplines. The four subdimensions of intellectual capital provide a more systematic way to integrate many knowledge-related determinants of innovation that have been studied separately. Based on the framework, it appears that most of the previous research has focused on only some specific aspects of intellectual capital, such as human capital and structural capital, while social capital and relational capital have remained understudied (Jansen et al., 2006). By bringing together the distinctive aspects of intellectual capital into a model, this dissertation provides a more comprehensive set of empirical evidence to understand the role of intellectual capital in improving innovation performances. From the empirical results of this dissertation, I can contrast the magnitude of impacts of each intellectual capital element and generate ideas as to which dimension of intellectual capital is more important to contribute to specific innovation projects. For example, a recent study asserts that cultural aspects are the strongest drivers of radical innovation over labor (e.g.,R&D employees) and capital (e.g., R&D expenditures) (Tellis, Prabhu, and Chandy, 2009). This dissertation also moves beyond previous research by examining interactions among intellectual capital elements. Accordingly, I contribute to the current research stream on the nature of various innovation mechanisms which can be substitutes or complements for another (Rothaermel and Hess, 2007).

Addressing four key intellectual capital elements, including human, structural, social, and relational capital supports practitioners in many ways. First, the guidance of subdimensions of intellectual capital helps managers identify, recognize, measure, and evaluate the different types of intellectual capital that should not be neglected for successful innovation projects. Currently, most top managers' understanding of intellectual capital remains limited since they tend to focus on financial analyses which cannot properly reflect the value of intangible assets (Molnar, 2004). Second, the relative importance of intellectual capital elements to be driven from this dissertation can shed light on managerial strateigies with respect to the resource allocation. Firms are experiencing scarce resources. Therefore, if it is possible, managers may want to select and invest in a particular intellectual capital element to achieve the success of an innovation project more efficiently (Roos, 1998). Third, understanding the possible interactions among the drivers of innovation leads to taking full advantage of the knowledge-related resources. If some intellectual capital elements are substituted for one another, managers do not have to utilize them simultaneously to increase innovation performance. If they did, it might result in decreased innovation at the margin (Rothaermel and Hess, 2007). On the other hand, when some intellectual capital elements are complements, a knowledge asset can be combined with its supporting assets in order to create more increases in innovation performance (Rothaermel and Hess, 2007).

1.4 Research Overview

This paper is organized in following ways. Part 2 represents a review of intellectual capital which consists of four subdimensions and the literature on radical and incremental innovation. Part 3 states hypotheses, focusing on a main argument that different innovation capabilities require different mechanisms of knowledge resource utilization. Part 4 describes the methodology, followed by the empirical findings in part 5. Then, theoretical and managerial implications will be discussed in part 6 with limitations and future research direction in part 7.

2 LITERATURE REVIEW

2.1 Intellectual capital

Intellectual capital is defined as the sum of intangible assets related to knowledge of a company that have been formalized, captured, and leveraged to produce a higher-valued asset and to create competitive advantage (Berry, 2004; Stewart, 1997; Subramaniam and Youndt, 2005). When firms build their intellectual capital and extract the value out of it, they can outperform especially in today's information and knowledge age (Hall, 1993; Hayes et al., 2005; Menor et al., 2007) However, managers experience difficulty in identifying and manipulating intellectual capital due to its nature of intangibility and diverse forms that it can take.

Intellectual capital encompasses not only the body of knowledge, but also tools and control mechanisms with which organizations direct and encourage organizational members to act in desired ways to stimulate the flow of knowledge (Stewart, 1997). Knowledge itself consists of two types: tacit and explicit (Nonaka, 1994). Tacit knowledge such as ideas, know-how, or skills of employees and external partners cannot be easily described or transferred. However, once transferred, it is difficult for the original owner of the knowledge to assert ownership (Edvinsson and Sullivan, 1996). On the other hand, codified knowledge such as news, market information, patents, and copyrights can be protected by the legal system since it is easy to imitate and to share. Tools (e.g., database, information technology system, etc.) and control mechanisms (e.g., business processes, communication cultures, etc.) are another component of intellectual capital to manage the tacit and codified knowledge.

In the last few decades, academic disciplines have provided different perspectives on intellectual capital. Table 2.1 summarizes definitions, examples of operationalization, and related literature spanning the diverse fields. A close examination of the literature conveys several interesting points. First, an extensive review suggests that we need to take a multidimensional view of intellectual capital in order to parsimoniously capture the concept. This multidimensional view can be illustrated by four components: 1) human capital, the collective knowledge of employees including experience, skills, and know-how; 2) structural capital, the specific knowledge owned by a firm such as technologies, processes, and data; 3) social capital, the knowledge emerged from informal interactions among the employees; and (4) relational capital, the knowledge embedded in relationships with external partners. The identified subdimensions implies that there are distinctive knowledge resources that firms can accumulate and utilize through individuals, structures, cultures and external partners (Berry, 2004; Stewart, 1997; Subramaniam and Youndt, 2005).

Second, there is varying degree of frequency that each of the aspects of intellectual capital is considered. Human capital and structural capital are included most frequently, while social capital and relational capital are referred to less in the literature. Most of the fields have focused on variables of greatest interest of their own. For example, the field of finance/accounting has addressed only measurable assets, while disregarding the aspect of social capital. The marketing field has mainly focused on customer relationships as the most important intangible asset to obtain profit. Information system field has paid much attention to structural capital in terms of types of information technology system to support knowledge management. Combined with the first observation, this finding reveals the need to integrate all the specialized arguments from each filed. Otherwise, the scattered arguments on intellectual capital will fail to offer a comprehensive and meaningful insight to practitioners regarding how to find and leverage important knowledge-related resources of a firm (Marr, 2005). Several recent empirical studies represent a more rigorous approach to the study of intellectual capital by accepting the multidimensional view (e.g., Menor et al., 2007; Subramaniam and Youndt, 2005). Yet, the examined constructs are defined and measured somewhat broadly so that more detailed discussion about how to manage various intellectual assets becomes difficult. The following sections detail each dimension.

Table 2.1 Definition, operationalization, and literature for the intellectual capital

	Definition	Operationalization				Literature
		Human	Structural	Social	Relational	
Economics	Knowledge, Intangible resources, Intellectual property	Quality of labor, Intelligence, Skills, Education level, Faculties supported by federal grant	Patents, Trade secrets, Trademarks, Copyrights, etc			Augier and Teece (2005), Lev (2001), Schankerman (1998), Zucker, Darby. and Brewer (1998)
Strategy/ Management / Human Resources	Knowledge, Intelligence of individuals, Technology, Brand image, Management skills, Ability to utilize its knowledge resources	Skills at employee, Knowledge worker Turnover rate, Experience, Education, Experience	Intellectual property, Trade secrets, Copyrights, Database, Regulatory routines, Process manuals, Information system	Corporate culture, Network ties, Shared codes, Trust, Norms, Obligations, Identification	Consumer trust, Relationship with stakeholders, Strategic alliance	Edvinsson and Sullivan, (1996), Eisenhardt and Martin (2000), Hall (1993), Hudson (1993), Lane and Lubatkin (1998), Nahapiet and Ghoshal (1998), Stewart (1997), Subramaniam and Youndt, (2005)
Finance/ Accounting	Market assets, Human-centered assets, Intellectual property assets, Infrastructure assets, Brand equity	Employees' Knowledge, Expertise, Problem solving Capability, Creativity	Distributions channels, Licensing, Contracts, Patents, Technology, Processes, Methodologies		Brand equity, The number of premium customers	Cezair, (2008), Fincham and Roslender (2003), García-Meca and Martínez, (2007), Johnson and Kaplan (1987)

Table 2.1 (cont'd)

Marketing	Customer capital, Strategic-marketing capabilities, Functional-marketing capabilities, Operational capabilities	Creative skills, Negotiating skills of sales force, Know-how	Market information, Market sensing procedures, New product development procedures, Packaging design, Implementing promotion, Customer relationship management	Shared mental model, Trust, Personal interaction	Customer relationships, Customer satisfaction, Customer loyalty, Retention rate, Brand equity, Price tolerance, Relationship with external stakeholders, Strategic partners	Brooking (1997), Fernström (2005), Stewart (1997), Srivastava, Fahey, and Christensen (2001) Madhavan and Grover (1998)
Information System	Knowledge, Technology	Individual knowledge, Skills	Information system, Intranet, Database, Routines, Documents, Problem solution sets	Organizational culture, Team culture		Alavi and Leidner (2001), Griffith, Sawyer, and Neale (2003), Schultze and Leidner (2002)
Operations Management	Operating know-how	Skilled work force	Information system, State-of-art manufacturing processes		Supply chain integration , supply base	Menor et al. (2007) , Choi and Krause (2006)

2.1.1 Human Capital

Human capital refers to knowledge that resides in employees, such as skills, experience, and problem-solving capabilities (Roos, 1998; Schultz, 1961; Stewart, 1997; Subramaniam and Youndt, 2005). No business can operate without people. As can be seen from Table 2.1, many disciplines have studied and emphasized human capital as the starting point of knowledge management and the main driver of organizational performance. Literature related to organizational learning theories asserts that knowledge embedded in individuals is necessary to acquire, interpret, distribute, and store new knowledge for an organization to improve its future performance (Fiol and Lyles, 1985; Huber, 1991; Sinkula, 1994). Innovation literature has also regarded human capital as the most important input factor. Examples include star scientists in organizations who have written numerous published articles, (Rothaermel and Hess, 2007), experts in multiple scientific areas (Cardinal, 2001), and a workforce with superior technical skills and knowledge (Menor et al., 2007; Subramaniam and Youndt, 2005), etc. Note that human capital cannot be owned by firms (Brooking, 1997; Stewart, 1997). Any knowledge and expertise of individuals will not stay within the firms as the workers retire or move (Daft and Weick, 1984), which implies that a special strategy to manage human capital is necessary.

2.1.2 Structural Capital

Structural capital should be distinguished from human capital in that a firm cannot deliver and hold the value of human capital without the employees themselves (Edvinsson and Sullivan, 1996). An organization's intelligence is not the sum of individuals' intelligence unless the knowledge of workers is shared and stored in a repository of the organization. The conversion of knowledge from private and tacit to public and explicit necessitates the use of institutionalized and codified knowledge captured in databases, patents, manuals, organizational structures, processes, and information systems (Subramaniam and Youndt, 2005). This is structural capital. The literature is rich with description of structural capital (see Table 2.1). This is probably because organizations can enjoy the ownership of structural capital, as opposed to human capital, social capital, and relational capital. The ownership implies that it is relatively easy for firms to measure and control structural capital. For example, accountants and finance people have not been successful in capturing the value of intellectual capital except for some structural capital such as patents and copyrights. The other aspects of intellectual capital are more difficult to reflect in financial reports due to their different cost structures in terms of ownership, depreciation, returns, and replacement cost (Stewart, 1997).

2.1.3 Social Capital

Social capital is the sum of the actual and potential knowledge embedded within the networks of mutual acquaintance and recognition among employees (Nahapiet and Ghoshal, 1998; Subramaniam and Youndt, 2005). The social network develops over time through informal interactions and provides the basis for trust and cooperation in an organization (Granovetter, 1985). Social capital should be distinguished from structural capital, which refers to formal procedures or managerial routines to collect and store individual knowledge. In the case of social capital, rather, informal and flexible interactions among employees can serve as another mechanism to create and share knowledge. Whereas structural capital cannot transfer tacit knowledge of employees to an organization's repository perfectly, social capital can be a facilitator in transferring uncodifiable knowledge of employees. Some of the tacit knowledge spreads only when people meet, talk, and interact (Stewart, 1997). Therefore, organizations need to establish a social activity to facilitate learning, in which tacit knowledge of individuals is spoken and shared for better use in the future (Ehin, 2000). This social activity tends to emerge over time and develops into organizational cultures, norms, and established patterns of behavior that are not easily influenced by individual mobility (Fiol and Lyles, 1985; Putnam, 1995). Specific examples include collaboration (Menor et al., 2007; Subramaniam and Youndt, 2005), trust (Fukuyama, 1995; Lane, Salk, and Lyles, 2001; Putnam, 1995), friendship (Richardson, 1986), entrepreneurial culture (Kang and Snell, 2009), mutuality (Ehin, 2000), obligations (Granovetter, 1985), etc. Learning through personal interactions becomes more important as the problems of innovation projects are getting technically more difficult and complex to solve alone (Levin and Cross, 2004). Nevertheless, there has been a lack of discussion on social capital except for strategy/management, marketing, and information system field (See Table 2.1).

2.1.4 Relational Capital

The nature of innovation has become more interactive in such a way that many interactions involved in innovation projects occur not only within a firm but also across the firm's boundary (Fischer, 2006). In the current knowledge economy, integrating external partners is imperative since they are valuable and effective sources of new information to innovate products and services successfully (Chesbrough, Vanhaverbeke, and West, 2006; Gatignon, Tushman, Smith, and Anderson, 2002). The recent explosion in alliances implies the importance of inter-firm routines and processes as another source of competitive advantage (Dyer and Singh, 1998). As the number of stakeholders and institutions related to an innovation project increases, it becomes critical to manage relational capital, which refers to knowledge resources embedded in the external relationships or networks (e.g., scientific, market, technical information, common language, workers, and know-how, which are specialized to the relationships) (Dyer and Singh, 1998; Freeman, 1991; Hayes et al., 2005; Miles, Miles, Snow, Blomqvist, and Rocha, 2009).

One example of relational capital is customer capital, defined as the value of the relationship of a firm with customers and captured by depth (penetration), breadth (coverage), and attachment (loyalty) (Stewart, 1997). Customer capital directly leads to profit since understanding customer needs properly determines the commercial success of an innovation (Teece, 2007). Accordingly, many disciplines such as strategy/management, finance, accounting, and marketing have examined customer capital in detail (See Table 2.1). Yet, relational capital can include not only the downstream relationship, but also the upstream relationship with suppliers. Although the empirical research has consistently supported the positive relationship between customer capital and innovation performance (Freeman and Soete, 1997), the role of supplier capital on enhancing innovation capabilities has remained unclear. Unlike other fields, operations management (OM) discipline is abundant with research on supplier involvement in new product development processes. However, most studies have focused on the attachment of supplier involvement (e.g., supplier obstructionism (Primo and Amundson, 2002), embeddedness with suppliers (Koufteros, Edwin Cheng, and Lai, 2007), supplier's specific investment and commitment to supplier (Song and Di Benedetto, 2008)), not on breadth or depth. From this perspective, supplier relationship capital or interorganizational relationships deserves more attention in an innovation context (Im and Rai, 2008).

2.2 The nature of innovation

Researchers have suggested many classifications of innovation: 1) administrative vs. technical (Daft and Becker, 1978; Kimberly and Evanisko, 1981) based on the objective of innovation adoption; 2) rational plan vs. communication web vs. disciplined problem solving (Brown and Eisenhardt, 1995) based on the performance measures; 3) competence enhancing vs. competence destroying (Gatignon et al., 2002; Tushman and Anderson, 1986) based on innovation's effect on a firm's competencies; and 4) radical vs. incremental (Damanpour, 1991; Dewar and Dutton, 1986; Ettlie et al., 1984; Nelson and Winter, 1982) based on the extent of change to technology. Among them, the last classification, radical innovation versus incremental innovation, has recently received much attention from researchers who are interested in organizational learning and dynamic capability (e.g. Benner and Tushman, 2003; Danneels, 2002).

Innovation emerges from a collective process where individuals and firms absorb, assimilate, exchange, and create knowledge (Fischer, 2006). Hence, the different innovation projects depend on different mechanisms of knowledge management (Cardinal, 2001; Kang and Snell, 2009; March, 1991). Organizational learning theories suggest that successful incremental innovations require the capability of *reinforcing prevailing knowledge*, while successful radical innovation projects necessitates the capability of *transforming prevailing knowledge* (Subramaniam and Youndt, 2005).

2.2.1 Incremental Innovation

Incremental innovation attempts to meet the needs of current customers or markets at a rate consistent with the current technological trajectory (Benner and Tushman, 2003; Gatignon et al., 2002; Jansen et al., 2006). The strategic focus of incremental innovation is market dominated growth with diversification by improving and expanding current products and services within a short time (Abernathy and Clark, 1993; Ettlie et al., 1984; Taylor and Greve, 2006). Incremental innovation projects call for the ability to reinforce, recombine, and take advantage of existing knowledge resources (Danneels, 2002; Subramaniam and Youndt, 2005). In this case, exploitative learning occurs with a narrow and in-depth search to take in well-defined solutions of a firm (Kang and Snell, 2009; Katila and Ahuja, 2002; Zahra and George, 2002). Outputs of incremental innovation projects are slight variations of existing products, services, practices or approaches (Damanpour, 1991).

2.2.2 Radical Innovation

Conversely, radical innovation seeks to meet the needs of emerging customers or markets (Benner and Tushman, 2003; Jansen et al., 2006). The magnitude of change in radical innovation is bigger than in incremental innovation. Based on an aggressive long-term strategy, organizations attempt to disrupt the prevailing technological trajectory and create new designs, technologies, and distribution channels for new markets (Abernathy and Clark, 1993; Ettlie et al., 1984; Gatignon et al., 2002). Accordingly, radical innovation projects build on knowledge resources that a firm does not yet have or that differ from existing resources (Danneels, 2002). In this case, exploratory learning becomes critical in that the firm needs to search a wide range of available knowledge to expand existing knowledge domain to novel or unfamiliar areas (Kang and Snell, 2009; Katila and Ahuja, 2002). Put differently, the success of a radical innovation project depends on the ability to make prevailing technologies obsolete by transforming the old knowledge into new knowledge, thereby producing fundamental changes in an organization (Damanpour, 1991; Subramaniam and Youndt, 2005). Although a radical project may results in a lower level of mean performance than an incremental project which utilizes existing knowledge, the increased variance of performance implies the high likelihood of significant profits that small increments in current products or processes cannot generate (Taylor and Greve, 2006).

A firm's dynamic capability derives from striking the balance between its incremental innovation capability and radical innovation capability (Benner and Tushman, 2003; Ettlie et al., 1984; Jansen et al., 2006; March, 1991). In dynamic capability literature, organizational capabilities are distinguished from their underlying microfoundations which refer to skills, processes, procedures, organizational structures, decision rules, and disciplines (Teece, 2007). Grounded on the perspective, this dissertation focus on addressing intellectual capital elements related to knowledge resources as the key micro-foundations that support a firm's innovation capabilities reflected in the performance of innovation projects.

Unlike the dominant theoretical arguments, empirical evidence has not consistently supported the idea that different mechanisms of incorporating knowledge resources are required to enhance the different innovation capabilities. For example, Jansen et al. (2006) studied antecedents of innovation capabilities by getting data from branch units of a big financial service provider. They found that formal processes (i.e., structural capital) represented by formalization and centralization do not support radical innovation, while social capital such as connectedness is an important antecedent for both innovation capabilities. On the other hand, Cardinal (2001) studied innovation performances at the organizational level in the pharmaceutical industry. The impacts of human capital (e.g., specialist diversity and professionalization) and structural capital (e.g., reward, performance appraisals, centralization, etc.) on the incremental innovation performance are not different from those on the radical innovation performance. Damanpour's (1991) meta-analysis also reveals that the significant impacts of human capital (e.g., variety of specialists), structural capital (e.g., centralization, internal communication, administrative intensity, etc.), social capital (e.g., attitude toward change), and relational capital (e.g., external communication) on innovation are not moderated by the radicalness. In order to unravel the present confusions, this dissertation will scrutinize different aspects of intellectual capital more comprehensively. More specifically, I will delve into individual impacts of intellectual capital elements at project team level on the performance of different innovation projects, a proxy of innovation capabilities of a firm. I also examine possible interrelationships among intellectual capital elements on innovation performance.

3 THEORY DEVELOPMENT

Incremental innovation and radical innovation collectively determine an organization's dynamic capability which can influence its competitive advantage (Benner and Tushman, 2003; Im and Rai, 2008; Jansen et al., 2006). Accordingly, it becomes imperative to achieve high performance in both incremental and radical innovation. Under the current competitive and turbulent environments, organizations need to innovate faster, better, and cheaper (Swink, Talluri, and Pandejpong, 2006). Increasing the efficiency of projects – whether they are incremental or radical ones – is a main concern of researchers and practitioners (Brown and Eisenhardt, 1995).

To structure the hypotheses, I depend on the main assumption that exploitative learning is necessary for an incremental innovation project which requires reinforcing existing knowledge, while exploratory learning is necessary for a radical innovation project which attempts to transforms the prevailing knowledge (Kang and Snell, 2009; Subramaniam and Youndt, 2005). I also adopt Subramaniam and Youndt (2005)'s premise that there are inherent differences in key elements of intellectual capital that a project team can utilize to selectively influence incremental and radical innovation performances (See Table 3.1). These intellectual capital elements could not only affect the two types of innovation in different ways, but also interact with each other to influence the innovation performances (See Figure 3.1).

Table 3.1 Main impacts of intellectual capital elements on innovation project performance

Intellectual Capital Dimensions	Intellectual Capital Elements	Incremental Innovation Performance	Radical Innovation Performance
Human Capital	Specialized Experience	H1A: +	H1B: -
	Generalized Experience	H2A: -	H2B: +
Structural Capital	Codified Knowledge	H3A: +	H3B: -
	Disciplined Methods	H4A: +	H4B: -
	Knowledge Transfer	H5A: -	H5B: +
Social Capital	Connectedness	H6A: +	H6B: ∩
	Psychological Safety	H7A: ∩	H7B: +
Relational Capital	Attachment of Relationship	H8A: +	H8B: -
	Depth of Relationship	H9A:+	H9B: -
	Breadth of Relationship	H10A: -	H10B: +

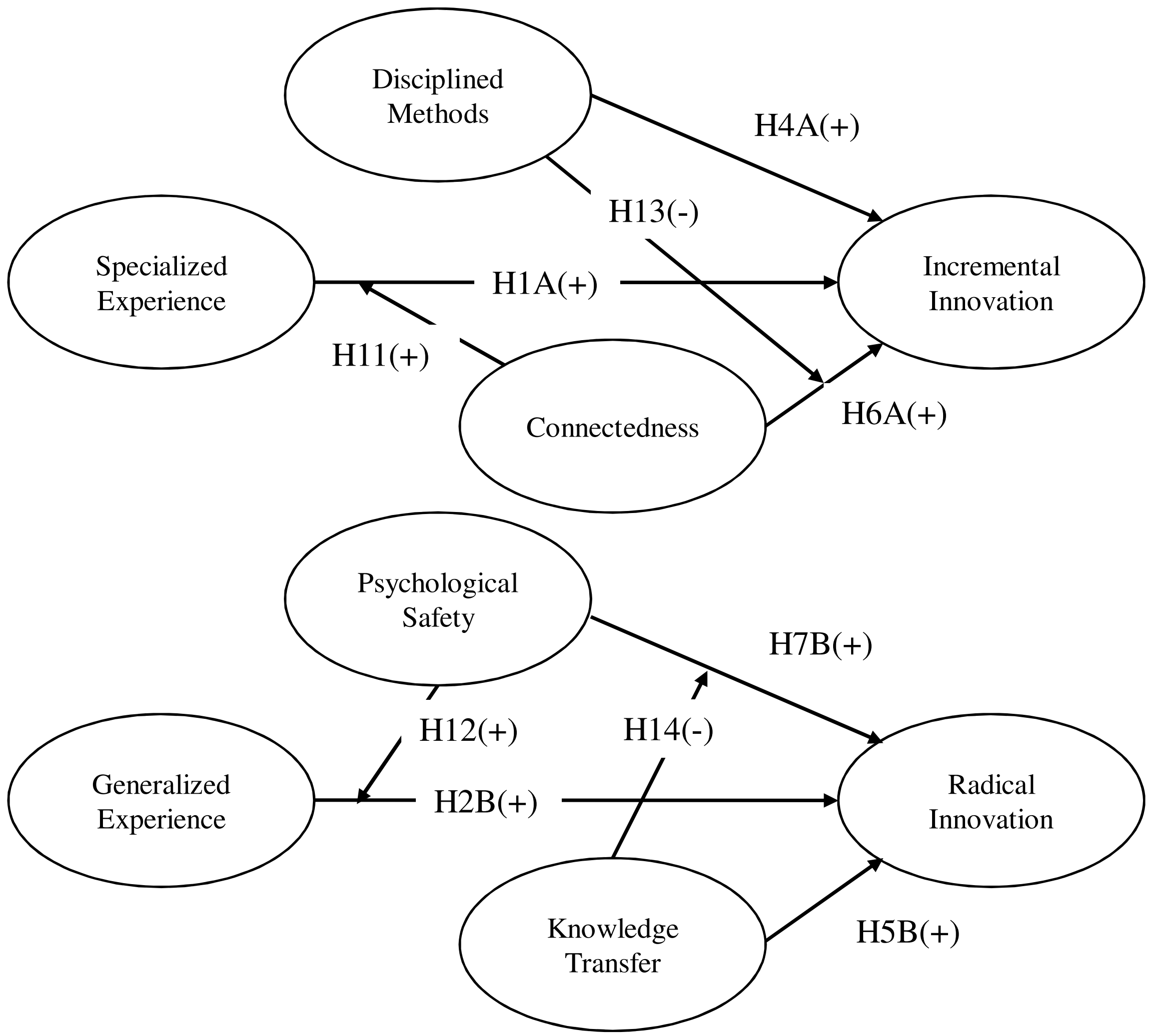

Figure 3.1 Interactions among intellectual capital elements

3.1 Effects of Human Capital Elements on Innovation Performances

A project team's problem solving abilities are an important aspect to explain the success of an innovation project (Brown and Eisenhardt, 1995; Katila and Ahuja, 2002). Human capital of a project team is one of the most important raw materials of the innovation since the solutions come from team members and the quality of the solutions depends on the amount of knowledge that they have (Lyles and Mitroff, 1980). Workers who have relevant experiences and knowledge may end up with good solutions to improve processes and products (Gordon, 1999; Iansiti, 2000; Stewart, 1997). The following questions then arise: what are the relevant experiences and knowledge that ultimately improve an incremental innovation project? Do they differ from those needed for a radical innovation project?

In order to assess the applicability of the relevant experiences and knowledge of team members to solve problems, search behaviors become important. The prevailing measures of human capital such as education level, publishing performance, or years of working do not capture the aspect of search behaviors well. The search behaviors of team members can be addressed by examining specialists versus generalists (Kang and Snell, 2009; Narayanan, Balasubramanian, and Swaminathan, 2009). The type of search behavior varies according to the type of expert, specialist or generalist and these search behaviors vary in appropriateness depending on the type of innovation project. Katila and Ahuja (2002) suggested two distinctive dimensions of search behaviors: 1) search depth, defined as the degree to which a search for solutions revisit prior knowledge, and 2) search scope, defined as the degree in which new knowledge is explored. Specialized knowledge and technical ideas obtained from an in-depth search is beneficial for incremental innovation. By contrast, when it comes to radical innovation, a broader search becomes more critical to capture new trends or opportunities in available technologies. Therefore, different innovation projects require different combinations of the two search dimensions. In the related literature, there has been lack of empirical efforts to examine the relationship between search behaviors of team members and the performance of innovation projects.

An in-depth but narrow search can characterize the search behaviors of specialists, who "have knowledge that is deeper, localized, embedded, and invested within particular knowledge domains” (Kang and Snell, 2009, p.68). Their in-depth knowledge on specific domains obtained from local search facilitates the understanding and assimilating of new knowledge if it is related to their knowledge domains (Cohen and Levinthal, 1990). The experience of specialists has accumulated from visiting the same knowledge domains repeatedly. Specialized experience offers a reliable guidance with which a project team can avoid false starts in its search for solutions and reduce the likelihood of errors during the search (Levinthal and March, 1981). The resulting deeper understanding of existing knowledge can generate solutions to improve current products and processes more efficiently (Katila and Ahuja, 2002).

Yet, the in-depth search behaviors of specialists can adversely affect radical innovations. Specialists tend to be committed to one specific view of problems by considering limited knowledge domains and less likely to modify the view (Lyles and Mitroff, 1980). Based on the perspective filter, specialists may choose only familiar information as relevant, while neglecting the other information that appears to be unrelated but is possibly important to solve the problems in an innovation project (Dougherty, 1992). Therefore, I posit that specialized experience of team-member specialists is appropriate for exploitative learning which in turns reinforces their knowledge domains within a local search, leading to a higher level of incremental innovation performance. By contrast, specialized experience of a team is not appropriate for radical innovation projects since it constrains exploratory learning to expand knowledge domains.

HYPOTHESIS 1A. *Specialized experience of a project team is positively associated with incremental innovation performance.*

HYPOTHESIS 1B. *Specialized experience of a project team is negatively associated with radical innovation performance.*

On the other hand, generalists are more suitable for exploratory learning which enhances radical innovation performance. A less deep but wide search can describe the search behaviors of generalists, who are “multi-skilled with a more versatile repertoire of capabilities that can be used across alternative situations” (Kang and Snell, 2009, p.68). For example, team members who have worked in different industries or have conducted different tasks can introduce novel approaches from the diverse areas to solve the innovation problems at hand. Boundary spanners or gate keepers constantly interact with scientific communities to be informed of new technologies and integrate them (Cardinal, 2001; Dougherty, 1992). Likewise, the broader search of generalists enriches the current knowledge pool of a team by adding new elements to it (Katila and Ahuja, 2002; March, 1991; Nelson and Winter, 1982). Accordingly, the possibility of finding new solutions for a problem increases. Exposing themselves to different technology domains, generalists adopt different premises or assumptions of each domain (Ahuja and Lampert, 2001). By doing so, they tend to be less attracted to preserved, specific knowledge domains and more flexible in acquiring new knowledge and skills (March, 1991). Diversity of perspectives driven from the generalized experience of team members enables brainstorming processes, thereby contributing to the creativity of their team (Cardinal, 2001).

However, the broader search at the expense of an in-depth search is insufficient for incremental innovation. Generalists may bring irrelevant information to the problem-solving activity, which does not contribute to understanding and resolving the existing technical issues. In an incremental innovation project to improve the performance of existing products and processes, a broad search across diverse knowledge domains can generate information that may cause task-related debates in terms of what to do and how to do (Jehn, Northcraft, and Neale, 1999, Narayanan et al., 2009). Disagreements due to the information diversity in the team will delay the entire project and demand more time and effort to resolve the conflicts (Pelled, Eisenhardt, and Xin, 1999). Therefore, I posit the following hypotheses:

HYPOTHESIS 2A. *Generalized experience of a project team is negatively associated with incremental innovation performance.*

HYPOTHESIS 2B. *Generalized experience of a project team is positively associated with radical innovation performance.*

3.2 Effects of Structural Capital Elements on Innovation Performances

An evident example of structural capital is codified knowledge stocks in the forms of documents, manuals, patents, or databases. When individual tacit knowledge is articulated or presented by words or graphics, the knowledge becomes explicit knowledge or information (Alavi and Leidner, 2001). Codified knowledge can support incremental innovation activities to a large degree. First, the records of the past such as library archives and databases enable team members to obtain effective references to solve problems related to current products and processes (Nonaka, 1994). In order to reduce times and costs for the in-depth search within an existing knowledge pool more significantly, many organizations incorporate information technologies such as memory systems that facilitate retrieval and distribution of information (Malhotra, Gosain, and Sawy, 2005). Second, people generally perceive codified knowledge to be more reliable, robust and legitimate (Katila, 2002). As a result, employees repeatedly use the accumulated knowledge for problem solving, thereby elevating the value of the codified knowledge stock further (Danneels, 2002; Lyles and Mitroff, 1980). This leads to a deeper understanding of the connections among existing knowledge elements so that team members are more likely to develop valuable ways to combine the elements for incremental innovation (Katila and Ahuja, 2002). Thus, codified knowledge which restores successful approaches of the past enables team members to refine and reinforce existing knowledge, thereby enhancing incremental innovation performance.

However, codified knowledge resources would not be good for radical innovation when they become core rigidities (Danneels, 2002). Due to its legitimacy and accessibility, team members may stick to the past knowledge that does not meet new environmental demands. The dependence on codified knowledge can generate encased learning behaviors of team members that affect the ways they respond to environments (Nelson and Winter, 1982; Stein and Zwass, 1995). As a result, the team members may not recognize the existence of quite different information that can be more useful for radical innovation. Moreover, members may continue to rely on existing knowledge because it can be significantly less costly than adopting or developing new knowledge (Henderson, 1993). Organizations usually spend much time and efforts to establish the specialized knowledge assets to serve the current market, while radical innovation makes the existing codified knowledge, at least partially, obsolete (Rajesh and Gerard, 1998). Accordingly, team members may be overly concerned about sunk cost invested in the knowledge resource and tend to keep utilizing them as much as possible. This behavior restricts the range of exploration and is harmful for radical innovation.

HYPOTHESIS 3A. *Codified knowledge is positively associated with incremental innovation performance.*

HYPOTHESIS 3B. *Codified knowledge is negatively associated with radical innovation performance*.

In addition to the codified knowledge that a project team can leverage, managerial processes or routines are also an essential part of structural capital of a firm to influence behaviors of employees (Roos, 1998). The regulatory control mechanisms have been a key interest in the innovation literature (Damanpour, 1991). A primary example of the control mechanisms is disciplined methods – often called formalization- , which refer to problem-solving steps in the written rules such as Stage-Gate or DMAIC (Define, Measure, Analyze, Improve, Control) (Choo et al., 2007; Jansen et al., 2006). Such a formal sequence of steps or a routine usually derives from the standardization of previously successful activities or best practices (Benner and Tushman, 2003). Therefore, disciplined methods can be a tool to assist team members in coping with problems and issues in an incremental innovation project (Henderson, 1993; Nahm, Vonderembse, and Koufteros, 2003). The mechanistic routines and procedures enable a project team to reduce time and effort to make decisions, thereby facilitating the entire project. By following the prior successful methods to deal with similar issues in the project, team members can respond to problems quickly and effectively (Rajesh and Gerard, 1998; Stein and Zwass, 1995). Put differently, disciplined methods constrain individual behaviors in a way that encourages employees to take existing knowledge stored at past routines and apply it to related innovation tasks (Kang and Snell, 2009). This process is manifested in a local search within technical domains related to current products or processes, which enhances incremental innovation performance (Jansen et al., 2006; March, 1991; Rosenkopf and Nerkar, 2001).

By contrast, the formalized rules and procedures to solve problems would not work well in radical innovation projects which are characterized by a high level of uncertainty and complexity. The nature of radical innovation necessitates employees' creativity and flexibility to deal with unexpected issues more effectively. Experimentation or autonomous works to explore new approaches enhance the creativity of individuals. However, disciplined methods do not allow team members to deviate from the confidently held written rules, which may not be appropriate to cope with the new environments (Cardinal, 2001; Jansen et al., 2006; Weick, 1979). As a result, the scope of a search for problem solving will be narrowed to knowledge residing at the current routines. Due to the accompanying penalty for rule violations, team members will become more averse to risk, thereby giving up trying new approaches (Henderson, 1994; Teece, 2007). Thus, disciplined methods could hinder the performance of radical innovation.

HYPOTHESIS 4A. *Disciplined methods are positively associated with incremental innovation performance.*

HYPOTHESIS 4B. *Disciplined methods are negatively associated with radical innovation performance.*

Structural capital that leads to variance-enhancing behaviors for radical innovation may differ from that for just improving the performance of current products or processes by reducing variances (Taylor and Greve, 2006). Knowledge transfer to deal with disruptive events is one of the variance-enhancing behaviors. Disruptive events refer to unanticipated interruptions that can disrupt the (highly automated) routines of work activities (Adler et al., 2009; Zellmer-Bruhn, 2003). Examples include introducing new machines, tools or other technologies, receiving an intervention from an authority or consultant, coping with structural changes such as recomposition of the group and redesign of the group task, setting new goals, encouraging experimentation during a project, etc (Adler et al., 2009; Gersick and Hackman, 1990). Disruptive events create new work environments with different workloads, job stress, coordination problems, and time pressure in project teams (Kirmeyer, 1988; Perlow, 1999). Naturally, such interruptions have been regarded as negative events which should be controlled and minimized. However, recent research asserts that the unanticipated changes in a project leads to acquisition of new knowledge if team members attempt to search more appropriate ways to deal with the challenges from outside of the team (Levinthal and Rerup, 2006; Zellmer-Bruhn, 2003).

Teams tend to stick with current or established routines to solve any problems driven by disruptive events. In this case, examining how other teams dealt with similar challenges in the past can help overcome the narrow, in-depth search for problem solving. By consciously participating in searching and acquiring new ways designed by other teams, team members can shift their attentions and take a fresh look at their current routines to solve the problems (Gersick and Hackman, 1990; Taylor and Greve, 2006). As a result, they could break out habitual practices or perceptions and become more likely to be involved in knowledge transfer across team boundaries. Therefore, knowledge transfer activities to solve unanticipated changes can offer a new context in which team members attempt exploratory learning for radical innovation.

On the other hand, in an incremental innovation project where the appropriate problem-solving procedures are well-structured, knowledge transfer activities could be simply distractions or bottlenecks that slow the project (Adler et al., 2009). Whenever new knowledge stimuli are introduced from outside of team, team members need to spend their time and energy to define the new situation and behavioral strategy to adjust to the new knowledge (Gersick and Hackman, 1990). The more new routines team members adopt from the other teams, the more questions about current task routines that they did not need to address in the past (Gersick and Hackman, 1990). The increased questions can shake team members' confidence about their ways of doing things. Therefore, knowledge transfer initiated by disruptive events hampers a project team's focused learning for efficient and fast problem solving which is required in an incremental innovation.

HYPOTHESIS 5A. *Knowledge transfer is negatively associated with incremental innovation performance.*

HYPOTHESIS 5B. *Knowledge transfer is positively associated with radical innovation performance.*

3.3 Effects of Social Capital Elements on Innovation Performances

As opposed to explicit knowledge that can be found in databases or procedures, tacit knowledge is captured and emerges through person-to-person interactions (Ehin, 2000). Hence, social capital is another essential aspect of intellectual capital (Nahapiet and Ghoshal, 1998; Richardson, 1986). Extant literature emphasizes the role of informal social mechanisms by which knowledge is shared and created in innovation activities.

Connectedness refers to the ease of direct contact among team members (Jansen et al., 2006; Jaworski and Kohli, 1993). The contact can be either actual (e.g., meeting, informal chat in the hall, etc.) or virtual (e.g., calling, email, etc.). When team members contact each other without any barriers in terms of time, place, and emotion, they can obtain and integrate the tacit knowledge of coworkers more rapidly based on the developed network ties or personal relationships (Burt, 1992). The improved efficiency in finding and obtaining knowledge is beneficial for an incremental innovation project where team members need to draw on prevailing knowledge in a timely manner (Jansen et al., 2006; Subramaniam and Youndt, 2005). The understanding of current products or processes is refined and deepened via frequent and smooth personal communications, which results in a high level of incremental innovation performance.

Connectedness also enhances the performance of radical innovation projects to some degree. The creation of new knowledge or scientific discovery requires that team members jointly participate in experimentations and discussions (McFadyen and Cannella Jr, 2004). The easy access to coworkers increases the amount of discussions and collaborations among people. Accordingly, connected team members are more likely to share and combine different knowledge elements to create new knowledge (Nahapiet and Ghoshal, 1998). However, the literature suggests a negative consequence of an extremely high level of connectedness in radical innovation. At some point, further connectedness forms similarities or strong norms among project team members, thereby limiting the team's openness to alternative ways of doing things and reducing its search scope (Jansen et al., 2006; Kang, Morris, and Snell, 2007; Nahapiet and Ghoshal, 1998). Therefore, I propose the following hypotheses:

HYPOTHESIS 6A. *Connectedness is positively associated with incremental innovation performance.*

HYPOTHESIS 6B. *There is an inverted U-shaped relationship between connectedness and radical innovation performance.*

Psychological safety is defined as the sense of "being able to show and employ one's self-image, status, or career" (Kahn, 1990, p.708). In such a culture, employees feel safe in taking the risk of expressing ideas to change existing systems (Edmondson, 1999; Roth, Marucheck, Kemp, and Trimble, 1994; Tu et al., 2006). By asking a question, seeking feedback, reporting a mistake, or proposing new ideas without interpersonal risks of being judged negatively, team members pursue variations in the problem-solving approaches (Edmondson, 2004; Stein and Zwass, 1995). Their search scope, thus, can be extended to outside the team. A project team with a high level of psychological safety is willing to invite customers and experts who do not belong to the team to the problem-solving process in order to acquire better ideas or feedbacks (Choo et al., 2007). Accordingly, the project team can produce unique and new solutions that substitute for prevailing knowledge, which leads to a higher level of radical innovation performance.

Psychological safety can also facilitate exploitative learning to support incremental innovation. When team members feel comfortable talking about any errors or mistakes that they have made, they are more motivated to share and discuss what they know and have experienced (Siemsen, Roth, Balasubramanian, and Anand, 2008). As a result, the project team can increase the awareness of existing products or processes via exploitative learning. Nevertheless, extremely high levels of psychological safety increase the amount of idiosyncratic opinions or ideas during an innovation project, which can disrupt the problem solving process. The resulting high costs of knowledge integration can be harmful for an incremental innovation project since a large part of the new ideas may be irrelevant to improving current products or processes (Katila and Ahuja, 2002). Therefore, I assert that the negative effect of psychological safety exceeds its benefits at some point in incremental innovation projects, whereas psychological safety supports racial innovation activities in general.

HYPOTHESIS 7A. *There is an inverted U-shaped relationship between psychological safety and incremental innovation performance.*

HYPOTHESIS 7B. *Psychological safety is positively associated with radical innovation performance.*

3.4 Effects on Relational Capital Elements on Innovation Performances

Intellectual capital also contains relational capital, which is another kind of social capital with external partners such as customers and suppliers. Relational capital implies that an organization can utilize, transfer and integrate knowledge stocks from outside (Kang et al., 2007). Three dimensions can specify the nature of relational capital: attachment of relationship, depth of relationship, and breadth of relationship (Stewart, 1997, p77).

Attachment of relationship refers to the degree of an emotional and proprietary tie developed through social interactions between partners. Attachment of relationship can take the form of loyalty (Stewart, 1997) or commitment (Krause, Handfield, and Tyler, 2007). Commitment is defined as "an implicit or explicit pledge of relational continuity between exchange partners" ((Dwyer, Schurr, and Oh, 1987) p.7). A high level of commitment implies that associated parties are willing to maintain their specific relationships by fulfilling mutual responsibilities, which results in a high level of satisfaction. Then, other potential partnerships are virtually precluded, and the high commitment relationships between the firm and current partners become unique and exclusive (Dwyer et al., 1987). Put differently, commitment represents the degree to which specialized skills and knowledge developed from a relationship are proprietary enough so that other competitors cannot easily imitate or access them (Stewart, 1997). Based on the commitment between parties, associate organizations can cultivate the norms of reciprocity or a high level of trust (Eisenberger, 1990; Kang et al., 2007; Putnam, 1995). The sense of mutual benefits motivates the partners to send and receive more knowledge (Gupta and Govindarajan, 2000). This collaborative knowledge sharing enhances incremental innovation. For example, committed suppliers can enable a manufacturing firm to reinforce the firm's existing knowledge by providing more expert skills and technical information about parts for its current products (Koufteros et al., 2007).

The association between attachment of relationship and radical innovation is unclear. With the fluent knowledge sharing and communication between an organization and its close customers, the firm can discover unsatisfied needs in the market, which leads to radical innovation. For example, many high-tech companies, such as Intel, have obtained novel ideas to make innovative products from loyal customers who are willing to share their complaints or thoughts on the products (Brooking, 1997). However, the unique relationship between external partners may impede spillovers from a firm's competitors, where spillovers are another main source for new knowledge (Fischer, 2006; Knott, 2008). Moreover, as a company develops relational capital with external partners, the knowledge created from these relationships becomes more redundant due to shared understandings, habits, experience, and languages (McFadyen and Cannella Jr, 2004). The convergence of resources between partners limits the scope of knowledge stocks that can be created from these relationships. If the external partners also interact with other competitors (i.e., the level of attachment of relationship is low), the new industry-wide knowledge can be easily transferred to the company, thus threatening radical innovation. Therefore, I propose the following hypotheses:

HYPOTHESIS 8A. *Attachment of relationship with external partners is positively related to incremental innovation performance.*

HYPOTHESIS 8B. *Attachment of relationship with external partners is negatively related to radical innovation performance.*

Another element of relational capital is depth of relationship, which represents the extent to which external partners get involved in the steps of an innovation project. External partner involvement in the project will generate inter-firm knowledge-sharing routines or interfaces that allow collaborating firms to identify valuable knowledge and transfer it across organizational boundaries (Dyer and Singh, 1998). Based on the formalized routines, partners share technical knowledge and fulfill sudden responsibilities, quickly as well as effectively (Brown and Eisenhardt, 1995). The overlapping knowledge bases due to the in-depth interaction with external partners play an important role in an incremental project. For example, suppliers usually have more specialized information and technical expertise about subsystems, parts, and materials than does their customer company. Therefore, working with the customer's engineers, the suppliers' engineers can provide valuable alternatives to improve the current products or processes in a timely manner (Koufteros et al., 2007).

The implications of depth of relationship on radical innovation are mixed. First, early involvement of suppliers and customers in an innovation project can change the final features of products or processes significantly in terms of technology, material, and functionality (Petersen, Handfield, and Ragatz, 2005; Song and Di Benedetto, 2008). Unless a firm combines the diverse ideas and knowledge from collaborating parties at the early stage of its project, the ability to make novel changes to the products and processes will be limited due to the predetermined specifications. Therefore, extensive interactions with external partners from the start of a project seem to be a prerequisite for radical innovation that incorporates effective searches, combinations, and the creation of new knowledge. However, the new product development (NPD) literature implies a threat of the early involvement external partners in cutting the flexibility of the innovation project. For example, manufacturing-related partners involved in the design phase can be detrimental for radical innovation. Under the notion of new product manufacturability, various functional parties collaborate early in NPD projects to ensure the fit between design and current manufacturing capabilities (Swink, 1999). Consequently, manufacturing related suppliers will constrain the creativity of designers or R&D parties, by asking them to adjust their new ideas according to existing manufacturing technologies (Adler, 1995). Therefore, I hypothesize the followings:

HYPOTHESIS 9A. *Depth of relationship with external partners is positively associated with incremental innovation performance.*

HYPOTHESIS 9B. *Depth of relationship with external partners is negatively associated with radical innovation performance.*

Another element of relational capital, breadth of relationship refers to the number of relationships with external partners (Burt, 1992; Stewart, 1997). In order to come up with radically new ideas, organizations need to constantly monitor and catch any opportunities associated with change in technologies and customer needs (Nelson and Winter, 1982). Therefore, including many external partners in an innovation project is beneficial in that a broad search among various sources of information becomes possible (Teece, 2007). Exploration that does not span organizational boundaries tends to 1) lock in the current system and 2) generate lower levels of subsequent technology evolution. (Rosenkopf and Nerkar, 2001). In general, the greater the number of organizations with different backgrounds involved in an innovation project, the more variance in ideas and more amount of knowledge those organizations generate (Schilling and Phelps, 2007; Tsai, 2001). By incorporating the different views from various partners, the project team will extend the scope of knowledge domain and obtain a new insight for radical innovation.

Nevertheless, the presence of too many partners may not be beneficial for an incremental project. Relationships with external partners require time and energy to establish and maintain the relationships (McFadyen and Cannella Jr, 2004). Combining the different views and ideas from the partners also incurs a high cost of information processing and negotiation (Nambisan, 2003). Accordingly, the involvement of many external parties in an innovation project may slow down the decision making process. When it comes to incremental innovation, those additional costs and time due to the presence of external relationships may exceed the advantage of sharing knowledge related to current products and processes.

HYPOTHESIS 10A. *Breadth of relationship with external partners is negatively associated with incremental innovation performance.*

HYPOTHESIS 10B. *Breadth of relationship with external partners is positively associated with radical innovation performance.*

3.5 Interactions among Intellectual Capital Elements

So far, the above hypotheses deal with the distinct effects of intellectual capital elements. In this section, I argue that some elements, when combined, will benefit innovation, while other combinations of intellectual capital elements could be detrimental to innovation. Examining how the value drivers of innovation interact with each other can exhibit important theoretical and managerial implications for the effective utilization of intellectual capital (Marr, 2005; Subramaniam and Youndt, 2005).

3.5.1 Interaction between Human Capital and Social Capital Elements

Human capital and social capital can interplay to amplify “people-embodied knowledge” (Bjurström and Roberts, 2007; Kang et al., 2007). Employees’ behaviors and cognitions are more likely to generate and facilitate shared knowledge when cultures and norms are characterized by the ease of contact or the ease of expressing ideas. (Ehin, 2000; Fiol and Lyles, 1985; Roos, 1998).

Combined with connectedness, specialized experience can contribute more to incremental innovation. Many project teams suffer from a lack of understanding regarding of the mechanism of knowledge transfer across members. For example, although a project member may face some type of problem and understand that other team members may help to resolve the problem, this collaboration often does not happen (Zellmer-Bruhn, 2003). In a working environment with many specialists, knowledge transfer becomes more difficult because organizations tend to maintain distributed knowledge structures in which specialists possess relatively little overlapping knowledge with each other (Kang and Snell., 2009). Top notch engineers or state-of-the art technicians usually do not interact with people and do not like to be told what to do (Hayes et al., 2005; Stewart, 1997). In order to refine the overall knowledge stock of a team for incremental innovation, the in-depth individual knowledge and experience of specialists should be tied to one another in some way (Subramaniam and Youndt, 2005). When they are connected to each other via formal meetings or informal interactions, specialists can search and mobilize their specialized knowledge more effectively for exploitative learning. Therefore, I posit that connectedness, a social capital element, complements specialists' experiences to enhance incremental innovation performance by permitting them to integrate and refine the distinctive knowledge of the specialists.

HYPOTHESIS 11. *Connectedness positively moderates the association between specialized experience and incremental innovation performance.*

In order to obtain usable ideas for radical innovation, a project team needs a diverse set of knowledge stock. Then, psychological safety, another element of social capital, complements the role generalists play in radical innovation by encouraging more flexible and broader searches. Although, generalists are valued for the variety of individual knowledge and experience that they potentially bring to a project, their value will not be realized under a culture that impedes their knowledge exploration and open discussion (Kang and Snell, 2009). If there is any penalty for questioning current paradigms, generalists in a project team are cognitively forced to limit their exploratory learning behaviors and find ways to take advantage of existing knowledge or technology. On the other hand, under a work environment in which team members are allowed to identify problems related to current approaches and participate in experimentation, they are motivated to deviate from past experience and develop new knowledge domains (Taylor and Greve, 2006). When their exploratory capabilities are unleashed, generalists can focus on reaching novel knowledge in diverse areas and getting ready to adapt any new emerging technological opportunities, which leads to a higher level of radical innovation performance.

HYPOTHESIS 12. *Psychological safety positively moderates the association between generalized experience and radical innovation performance.*

3.5.2 Interaction between Structural Capital and Social Capital Elements

Connectedness of team members indicates the strength of ties with respect to the ease and the frequency of communication (Granovetter, 1973; Siemsen et al., 2008). Employees working under a high level of connectedness, who have strong ties, can easily identify and utilize existing knowledge within a team. Put differently, strong ties reduce the cost of knowledge transfer among people (Szulanski, 1996). As a result, a project team can effectively generate and refine redundant information, which defines exploitative learning, because everyone in the team is able to capitalize on what the others know (Hansen, 1999). However, the use of disciplined methods for problem solving is another mechanism to decrease the cost of knowledge transfer. The formally written procedures or rules stored at manuals are mechanisms to encourage the use of codified knowledge of an organization. Following the disciplined methods, team members should access or utilize the explicit knowledge that usually derives from successful experience in the past and related knowhow (Benner and Tushman, 2003; Nonaka, 1994). In this case, the connectedness through personal interactions becomes less important to obtain or to revisit the existing knowledge resources of a project team. Therefore, I suggest that disciplined methods and connectedness are substitutes for each other.

HYPOTHESIS 13. *Disciplined methods negatively moderates the association between connectedness and incremental innovation performance.*

When useful innovation routines or knowledge are transferred from other teams, it is important to overcome the team members' tendency to go back to the past. Then, a high-level of autonomy, which characterizes the culture of psychological safety, may hinder the implementation of transferred knowledge for radical innovation. As the perceived ease of expressing ideas and thoughts increases, so does the potential for criticism for new routines developed by others. The rise in the number of complaints about new initiatives may discourage the aspirations to adopt and implement them. Likewise, if knowledge transfer activities are combined with psychological safety, the resulting new suggestions and conflicts to be addressed may generate job stress, work overload, time pressure, confusion, and increased error rates of team members (Fiol and Lyles, 1985; Zellmer-Bruhn, 2003). Therefore, I hypothesize that promoting psychological safety becomes less important for radical innovation when a team has already undergone knowledge transfer activities.

HYPOTHESIS 14. *Knowledge transfer negatively moderates the association between psychological safety and radical innovation performance.*

4 METHOD

4.1 Data Collection

The main intent of this dissertation is to test a set of hypotheses to address how the relationships between intellectual capital elements and project performance can change in response to the radicalness of innovation projects. Therefore, the unit of analysis is an innovation project.

The target population for this study is innovation projects that have been recently conducted in manufacturing companies in the United States. Both product and process innovation projects are included to obtain more generalizable implications on innovation activities. Target respondents are mid-to-high-level managers and engineers who have been directly involved in a completed innovation project in 2009. Personnel at these levels with direct involvement experience have substantial knowledge about the entire process of their projects. Therefore, their answers pertaining to variables in this study would be very reliable. By asking them to respond with respect to one of the most recently completed projects, I intended to avoid possible selection bias. Tendencies to select certain types of innovation projects (e.g., more successful, large-scale, or internally-driven projects) over the other are thereby reduced. This approach also helps to minimize measurement error due to long-term retrospective recall effects (e.g. Choo et al., 2007).

In order to obtain more representative data of innovation projects of manufacturing companies in different sizes, geographical locations, and industries, I used two databases. The sampling frame consists of companies in the CorpTech database and the Society of Manufacturing Engineers (SME) database. The CorpTech database provides over 13,000 mailing lists of private and public high-tech companies in knowledge-intensive industries, such as biotechnology, computer technology, telecommunications, and medical equipment. I input a set of key words, “Research and Development”, “Engineering”, “Manufacturing”, and “Product Management”. “Chief Technical Officer” “Chief Executive Officer”, in the job function field to identify appropriate respondents who were likely to have been involved in product or process innovation projects. A total of 2,505 contacts were returned. A similar approach was taken for the SME database, which includes more than half a million manufacturing practitioners across different industries. Key words used in the SME job function field were “Manufacturing Production”, “Manufacturing Engineering”, “Product Design”, “R&D”, “Quality Management”, and “Factory Automation”. Then, a set of key words in the SME job title field were used to identify mid to high level personnel, including ‘Director”, “Leader”, “Executive”, “Vice President”, and “Management”. As a total, 1,000 contacts were randomly selected. This formed a total 3,505 contacts.

Between February 2010 and July 2010, I collected data online by following appropriate administrative procedures for survey research suggested by Dillman (2000) to increase the response rate. Electronic surveys are generally as effective as print surveys and also have some advantages such as having more complete data and more ease in customizing the questions (Boyer, Olson, Calantone, and Jackson, 2002). The appearance of the survey was refined to be user-friendly by using different colors, interactive skip functions, and error detecting messages.

Multiple contacts were made. Initially, personalized e-mail invitations which described the nature of the survey were sent out by Qualtrics System. Three weeks were given to the recipients to fill out the answers. Each e-mail had a customized link that brought the respondent directly to the survey. Since responses collected through the system were stored in a protected database, respondents could stop answering the survey and come back at any time they wanted.

As an incentive, all of the respondents were promised to receive an executive summary report which addresses the implications of this dissertation. One week after sending out the invitation letters, each person was contacted by telephone to check if he or she was able to receive the invitation letter without any technical problems. One week before the due date, final reminders were sent out to persuade the recipients to respond to the survey.

4.2 Sample

Out of 2,505 contacted people in the Corptech database, 103 took the survey. 934 emails got bounced back due to invalid e-mail addresses and 463 emails failed to be delivered due to security problems. Therefore, the response rate was 9.3 % (= 103/ (2505-934-463)). I excluded 9 incomplete responses, which indicates that the final sample consisted of 94 innovation projects. For the SME database, 306 emails out of 1,000 were returned since there were no corresponding recipients. 156 people participated in the survey, representing a 22.4% response rate, although 38 responses were insufficiently answered. The final sample comprised 118 projects. Student's t-tests revealed no significant mean differences among the two databases with respect to the variables in this dissertation (all the t-tests were nonsignificant). I therefore used the entire sample of 212 projects to test hypotheses. Examples of the innovation projects performed by these respondents are the making of modifications to improve the current products/processes reliability, the development of a process or product to implement disruptive technology, of new software products for supply chain management, of a new type of component module for better use of batteries, of an accessory that interfaces with iPhone, etc. Table 4.1 and Table 4.2 summarize the distribution of the 212 observations in the final sample for future analyses. The final sample represented a wide range of industry groups, including some of responses from professional consulting companies and software companies. Theses helped manufacturing companies design, install, and launch new processes or products.

Table 4.1 Industries represented in the sample

Industry (NAICS code)	%
Chemical Manufacturing (325)	3.64
Plastic and Rubber Manufacturing (326)	3.13
Fabricated Metal Product Manufacturing (332)	23.44
Machinery Manufacturing (333)	20.83
Computer and Electronic Product Manufacturing (334)	13.02
Electrical Equipment, Appliance, and Component Manufacturing (335)	6.25
Transportation Equipment Manufacturing (336)	9.90
Furniture and Related Product Manufacturing (337)	4.17
Miscellaneous Manufacturing (339)	7.29
Software Publisher (511)	5.73
Professional, Scientific, and Technical Services (541)	2.60
Total	100%

Table 4.2 Sample characteristics

Respondent's Position	%
Executive sponsor/champion	28.30
Project manager	29.72
Functional manager	17.45
Engineer or other trained professional	37.73
Consultant/Contract Employee	2.83
Researcher	8.02
Other (e.g., architect, black belt, machinist, etc.)	1.42
Project Type	%
A product innovation project	34.29
A process innovation project	40.00
A product and process innovation project	25.71
Project Radicalness	%
Low competence radicalness & low market radicalness	36.80
Low competence radicalness & high market radicalness	17.45
High competence radicalness & low market radicalness	17.45
High competence radicalness & high market radicalness	28.30
Firm's Employment	%
Between 100-500 people	37.68
Between 501-1,000 people	17.04
Between 1,001-5,000 people	21.26
More than 5000 people	23.67

4.3 Nonresponse bias

In order to evaluate possible non-response bias, I followed wave analysis and the follow-up approaches (Rogelberg and Stanton, 2007). First, a wave analysis was performed by comparing early responders to late responders (Armstrong and Overton, 1977). For both databases, I selected the first 30 questionnaires, which were returned before follow-up calls, and the last 30 questionnaires returned before the due date. The two groups were compared with respect to all the study variables for this dissertation. Student's t-test comparisons revealed no significant mean difference (p-value > 0.1) between the first and last groups.

Second, I conducted simple telephone interviews with 100 randomly selected nonrespondents to examine why they chose not to participate in the survey. 29 people said that they were not involved in any recently completed innovation projects. 52 people mentioned that they had no time to complete the survey. 11 people were simply not interested in the survey. 8 people said that their firms do not allow any survey participation. No other specific reasons that might explain the difference between respondents and non-respondents were identified. Given these facts, I assume that 29 percent of recipients might be ineligible and could be excluded from the population when calculating response rates. For the Corptech database, the recalculated effective response rate turns out to be 13.1% (=103/ ((1-0.29)*(2505-934-463))). For the SME database, 31.6% (=156/((1-0.29)*(1000-306))). These effective response rates are fairly high, thereby mitigating the risk of having nonresponse bias.

Finally, in order to examine nonresponse bias more systematically, I additionally asked the actual nonrespondents to fill out an abbreviated version of the questionnaire which included only 7 measurement items. The items were associated with two key constructs for this research, market radicalness and competence radicalness. 24 questionnaires were received and compared to the entire 212 responses with respect to the 7 items. Student's t-tests for differences in means indicated no significant difference between the respondent group and the non-respondent group (p-value > 0.1). Taken together, I conclude that there is no systematic difference between respondents and nonrespondents, and the collected sample can reasonably represent the population of innovation projects conducted in manufacturing companies.

4.4 Measurement Instrument

4.4.1 Construction

In order to develop measurement items for this dissertation, I adopted well-defined and validated scales from the existing literature whenever possible. However, in order to further ensure the construct validity of the survey measures under the specific research context of this dissertation, I employed manual factor sorting procedures that were suggested by Stratman and Roth (2002).

At the first round of sorting, four doctoral students at Michigan State University were invited to participate in the process. I provided them with descriptions of each construct and a randomized list of all of the measurement items. The doctoral students were requested to assign each item to a construct that they think the item intended to measure. Then, the item placement ratios were calculated to assess inter-judge agreement and construct validity (Moore and Benbasat, 1991). The ratios ranged from 60% to 100%. During the process, I identified the items that were not consistently classified into their target constructs. The problematic items were carefully examined and reworded appropriately.

I iterated the same procedure one more time with four new doctoral students. Each panel was given the revised measurement items. At the second round of manual sorting, all the item-placement ratios were above 90% and definitely exceeded the criterion of 70% that was suggested by Moore and Benbasat (1991). Therefore, I concluded that the refined measurement items were acceptable.

To ensure the validity of the measures further, I asked three faculty panels to examine the questionnaire under the actual online survey setting. They are experts and qualified in conducting surveys about innovation projects. Based on their reliable comments, I adjusted wording and layout of several questions before finalizing the survey. Consequently, I established the ultimate set of constructs and corresponding measurement items successfully.

4.4.2 Measurement Items

As mentioned earlier, I adapted or developed measures from extant research. All multi-item measures in this dissertation had a seven-point Likert scale (1 = Strongly Disagree; 7 = Strongly Agree). Table 4.3 and Table 4.4 contain a list of all measurement items and corresponding constructs.

Human Capital Measures

Specialized Experience

Specialized Experience measures project team members' in-depth knowledge of a particular domain. Based on Ettlie et al. (1984), Kang and Snell (2009), and Taylor and Greve (2006), I conceptualized this variable as the percentage of specialists on a project team. I asked survey participants to rate the percentage of team members that had in-depth expertise in a single or few specialized tasks (such as sales/marketing, design, programming, manufacturing, etc), yet had little knowledge of other task areas.

Generalized Experience

Generalized Experience characterizes a project team's less deep but more versatile knowledge across different domains, which enables a broad search for problem solving. This variable developed from Damanpour (1991), Kang and Snell (2009), and Taylor and Greve (2006). Participants rated the percentage of team members that had a wide range of knowledge spanning multiple task areas, yet had limited specialized expertise in any given area.

Structural Capital Measures

Codified Knowledge

Codified knowledge refers to the degree to which knowledge has been codified and stored so that it is ready to be used for an innovation project team. I developed 6 items based on Alavi and Leidner (2001), Cummings (2004), Malhotra et al. (2005), Menor et al. (2007), and Subramaniam and Youndt (2007) (See Table 4.3).

Disciplined Methods

Disciplined Methods measures the degree to which procedures and communications to implement innovation projects are formalized or written down. I adopted four items from Choo et al.(2007), Nahm et al. (2003), and Jansen et al. (2006) (See Table 4.3).

Knowledge Transfer

I adopted 4 item from Adler et al. (2009), Choo et al. (2007), and Zellmer-Bruhn (2003). . The items measure a project team's intended learning behavior to acquire knowledge from outside of team to deal with disruptive events (See Table 4.3). The disruptive events include unanticipated changes in machines, tools, technologies, roles of team members, project goals, etc.

Social Capital Measures

Connectedness

Connectedness conceptualizes the ease of direct contact among team members. I adopted 4 measurement items from Jansen et al. (2006) (See Table 4.3).

Psychological Safety

Psychological safety refers to the degree to which team members feel safe in taking the risk of expressing ideas and thoughts for their innovation project. I adopted 4 items from Choo et al. (2007), Edmondson (1999), and Siemsen et al. (2009) (See Table 4.3).

Relational Capital Measures

Attachment of Relationship

This construct measures the degree to which firms conducting innovation projects commit to a long-term relationship with their key external partners. In most cases, the relational asset is developed and nurtured through social interactions and can be considered to be proprietary. I adopted four measurement items from Krause et al. (2007), Morgan and Shelby (1994), and Song and Di Bebedetto (2008) (See Table 4.4).

Depth of Relationship

Depth of relationship measures the extent to which key external partners get involved in the steps of an innovation project. Put differently, this construct addresses the level of integration of external partners into the new product or process development activities. Customers or suppliers could provide appropriate expertise and suggestions toward the entire stages of a project, from design stage to test stage. Four items were adopted from Koufteros (2007), Morgan and Shelby (1994), Song and Di Bebedetto (2008), Primo and Amundson (2002) (See Table 4.4).

Breadth of Relationship

Breadth of relationship refers to the number of external partners directly involved in an innovation project. I requested survey participants to provide the number of external partners for each category as following: Vendor/Suppliers; Customers; Government representatives; University consultants, Private consultants; Unpaid technical/professional colleagues; and Specified others. Mathematically, breadth of relationship is equal to the sum of numbers across the different types of external partners.

Performance Measures

As discussed in section 3, increasing the efficiency of innovation projects is a main interest of this dissertation. Therefore, time performance, which refers to adherence to schedule, and cost performance, which indicates adherence to budget, are the ultimate dependent variables. Three perceived project success scale items for each performance construct were developed based on Primo and Amundson (2002), Swink (2002), and Mallick and Schroeder (2005) (See Table 4.3).

Control Variables

In addition to intellectual capital elements, I include several control variables, which prior research has identified as associated with project performance. By doing so, possible confounding effects can be reduced.

Team Size

Team size may affect intra-team communication, thereby influencing project performance (Kearney, Gebert, and Voelpel, 2009). However, its main impact on the performance outcome is not clear. Larger teams tend to have more resources available for their projects but, at the same time, may be too inflexible to accomplish innovation (Jensen et al. 2006). Thus, I included team size as a key control variable. Team size was measured by the sum of the number of full-time employees and the number of part-time employees at the peak of the development effort.

R&D Spending

I also include R&D spending as another control variable. A firm's R&D expenditure affects the amount of search activities, making the firm more or less capable of accomplishing innovation (Katila and Ahuja, 2002). I measured R&D spending using an ordinal scale: 1 = between 0 and 3 (%); 2 = between 3 and 5 (%); 3 = between 5 and 7 (%); 4 = between 7 and 9 (5); 5 = More than 9 (%).

Top Management Team Commitment

Top management team commitment refers to top management's willingness to support an innovation project within the firm and allocate the resources required for successful development of products or processes in a timely manner. I adopted 4 items from Chen and Paulraj (2004) (See Table 4.3).

Radicalness

Radicalness of a project characterizes the degree of uncertainties that innovation project teams experience to develop new products or processes. The inherent project uncertainties consist of both external market/technology aspects and internal competence aspects (Griffin and R.Hauser, 1996; Ruekert and Walker, 1987). Serving a new set of customer needs or introducing new technologies to the industry increases uncertainties in terms of project directions. In this case, the level of market radicalness is high. However, the level of internal competence radicalness could vary independently from the external market radicalness. For example, competence radicalness increases when firms launch new business units. Team members may have no expertise in products or processes which serve the new units. Then, competence radicalness is high since the members need to invest much effort to obtain new skills or knowledge before implementing an innovation project. The market radicalness could be still low if the technologies that they want to learn and adopt have been widely used in the industries. Seven items were adopted from Gatignon (2002), Govindarajan and Kopalle (2006) and He and Wong (2004) to cover the external market and internal competence radicalness (See Table 4.3). I examine whether the seven items can be grouped to indicate a variable of project radicalness or not.

4.5 Scale Reliability and Validity

4.5.1 Construct Reliability and Validity

This dissertation integrates critical elements of intellectual capital from different academic fields into one research framework. As a result, assessing the quality of constructs as a whole becomes more important to see if the constructs can be distinguishable from one another and be used across disciplinary boundaries. Before conducting a confirmatory factor analysis (CFA), I noticed one feature in the data: 108 out of 212 projects were implemented without external partners. Therefore, in the 108 responses, the measures for the relational capital factors (i.e., attachment of relationship and depth of relationship) do not exist. Due to this nature of the data, I decided to run two different sets of CFA.

The first CFA analysis is associated with structural capital, social capital, project performance, and project radicalness. Table 4.3 reports the CFA results based on 212 project samples. Two relational capital elements - attachment of relationship and depth of relationship - were excluded here since about half the project samples have no external partners and do not have the values for the two elements. The measurement model indicated a good fit with Bentler-Bonett non-normed fit index (NNFI) = 0.901, comparative fit index (CFI) = 0.923, Bollen's fit index (IFI) = 0.925, and RMSEA=0.052. All factor loadings of the measurement model were above 0.5 and statistically significant ($p < 0.05$), which represents acceptable convergent validity for all constructs (Bagozzi, Yi, and Phillips, 1991). Except for cost performance which had two measurement items, every construct had at least three measurement items. This evidence supports content validity for constructs since multiple items can address multiple dimensions of each construct. I assessed construct reliability by calculating Cronbach's alpha coefficients for each construct. All of the scales were above 0.7, and therefore seemed to be reliable (Nunnally, 1978). I also examined composite reliability suggested by Fornell and Larcker (1981). All the reliability values met the minimum acceptable level of 0.60. I calculated the average variance extracted (AVE) for each construct to test discriminant validity more systematically. All AVE values were above 0.47 and greater than the squared correlation values of its corresponding construct and the other constructs, which suggests adequate discriminant validity (Fornell and Larcker, 1981). Before moving on, I conducted another CFA to see if the seven items of project radicalness to indicate a common factor. In order to obtain acceptable fit indices, I had to drop all of the four measurement items for market radicalness. Moreover, the final fit indices were not better than ones from the previous CFA. Therefore, I decided to hold two separate variables of project radicalness, including market radicalness and competence radicalness.

The second CFA used 104 project samples in which external partners were involved. Table 4.4 exhibits the CFA results with two relational capital elements: attachment of relationship and depth of relationship. This measurement model fits the data well since chi-square value is insignificant (at $p < 0.25$). Going into details about reliability measures, Cronbach's alpha values for attachment of relationship and depth of relationship were 0.687 and 0.747, respectively. An alpha score of 0.6 is generally acceptable (Moss et al., 1998), although this criterion is not as strict as the more widely recognized 0.7 threshold suggested by Nunnally (1978). Composite reliability values were 0.595 and 0.754, respectively. The composite reliability of attachment of relationship is close to the cut-off value 0.6. Therefore, these assessments represented adequate reliability for the two relational capital elements. The standardized loadings of all the measurement items on their respective constructs were above 0.5 and significant ($p < 0.05$), which suggested acceptable convergent validity and unidimensionality. The comparison between AVE values and the squared correlation values provided strong evidence of discriminant validity. Each construct had at least three measurement items, still maintaining content validity. Overall, I concluded that the proposed factor models in Table 4.3 and Table 4.4 fit the data well and the measures utilized in this dissertation were internally consistent as well as valid.

Table 4.3 CFA results

Construct and Measurement Items [a]	Standardized loadings	AVE	Composite Reliability	Cronbach's alpha
Codified Knowledge		0.475	0.782	0.779
The team had patents and licenses available for the innovation project.	Dropped			
Much of available knowledge for the project was contained in the form of manuals, archives, or databases.	0.625			
Information systems were available to codify, store, and retrieve project-related knowledge.	0.804			
The team was able to get documented information about previous projects such as their problems, preliminary findings, outcomes, recommendations, and evaluations.	0.664			
The team often used our firm's past patents and licenses for the innovation project.	Dropped			
The team often used information systems to browse and utilize internal knowledge of our organization.	0.650			
Disciplined Methods		0.679	0.862	0.849
Project team members strictly followed rules and procedures (For example, six sigma or other procedural guidelines).	0.786			
Team members put a high priority on following formal project management rules and procedures.	0.951			
Formal progress reviews (such as design, gate, phase, or stage reviews) were faithfully held to guide the overall project process.	0.718			
Team members' work was rarely checked for rule violations. *(Reversed)*	Dropped			
Knowledge Transfer		0.585	0.806	0.786
Team members extensively searched for information from outside the team to deal with unanticipated changes.	0.731			
The team often invited people from outside the team to discuss and learn how to deal with unanticipated changes.	0.883			

Table 4.3 (cont'd)

The team tried to find out how other teams within the firm dealt with similar unanticipated changes.	0.664			
Team members adopted many new processes to deal with unanticipated changes.	Dropped			
Connectedness		0.686	0.866	0.844
When team members needed to talk, they had ample opportunity for informal "hall talk".	0.663			
When team members needed to talk, they were able to find and contact each other promptly.	0.914			
When team members needed to talk, they were quite accessible to each other.	0.885			
When team members needed to talk, it was easy to access virtually anyone, regardless of rank or position.	Dropped			
Psychological Safety		0.648	0.892	0.813
Team members were able to discuss tough issues openly.	0.731			
Team members accepted each other's opinions.	0.875			
Team members felt comfortable talking with coworkers about errors that they made.	0.802			
No one on the team deliberately acted in a way that undermined other members' efforts.	0.543			
Time Performance		0.696	0.867	0.844
The project was completed on time in terms of its originally projected schedule.	0.974			
The project progress adhered to its originally projected schedule.	0.925			
This project took much longer than the usual amount of time for similar projects undertaken by the unit. *(Reversed)*	0.534			
Cost performance		0.832	0.908	0.901
The project was much costlier than expected. *(Reversed)*	0.991			
Actual costs spent on the project were higher than originally estimated costs. *(Reversed)*	0.826			
The projected was completed within its original budget.	Dropped			

Table 4.3 (cont'd)

Top Management Team Commitment		0.577	0.801	0.792
Top management emphasized the importance of the project.	0.641			
Requests for increased resources were mostly satisfied by top management.	0.720			
Top management relinquished authority to the project team for decisions.	Dropped			
Top management supported the project team's needs very well.	0.896			
Market Radicalness		0.525	0.767	0.761
The project relied on technology that had never been used in the industry before.	0.768			
Entering new technology fields was very important in the project.	Dropped			
The project created products or processes that were totally new to the market.	0.771			
Opening new markets was very important in the project	0.626			
Competence Radicalness		0.542	0.772	0.746
The project required significant changes in the products or processes of my business unit.	0.500			
Team members had to learn new skills and procedures for the project.	0.839			
Much training was required for team members to initiate the project.	0.819			
NNFI = 0.901; CFI = 0.923; IFI = 0.925; RMSEA=0.052 ; 90% confidence interval of RMSEA = (0.044, 0.060) Chi-Square = 613.951 (d.f.=389); p-value < 0.000				

[a] n = 212 projects.

Table 4.4 CFA results for relational capital constructs

Construct and Measurement Items [a]	Standardized loadings	AVE	Composite Reliability	Cronbach's alpha
Attachment of Relationship		0.449	0.595	0.687
My firm was more committed to this partner than it was to other partners from similar projects.	0.679			
My firm had a longer-term relationship with this partner than it did with other partners from similar projects.	0.796			
My firm intended to maintain the relationship with this partner more than it did with other partners from similar projects.	Dropped			
The relationship with this partner deserved my firm's maximum effort to maintain more than relationships with other partners from similar projects.	0.501			
Depth of Relationship		0.506	0.754	0.747
This partner was heavily involved in early stages of the innovation project.	Dropped			
This partner provided much input on the design of the product or process.	0.759			
This partner provided its expertise in product/process testing.	0.667			
Our communications with this partner regarding quality and resulting design changes were very close.	0.704			
NNFI = 0.968; CFI = 0.983; IFI = 0.84; RMSEA=0.051 ; 90% confidence interval of RMSEA = (0.000, 0.133) Chi-Square = 10.155 (d.f.=8); p-value < 0.254				

[a] n = 104 projects with external partners.

Finally, using objective measures, I assessed criterion validity for two performance constructs: time performance and cost performance. I compared the time performance scores with the actual weeks saved against the original schedule, which was calculated by the following equation:

Percentage of Time Saved (PTS) = (intended length of time from beginning of project until end of project –actual length of time from beginning of project until end of project) / (intended length of time from beginning of project until end of project)

This measure was available for all 212 samples. The Pearson correlation between time performance and PTS was 0.322 and statistically significant ($p < 0.01$). The more conservative, non parametric Kendall's tau-b correlation was 0.529 and also statistically significant ($p < 0.01$). This result implies strong consistency between an objective indicator of time performance of a project and respondent's perceptions of time performance.

Cost performance was compared with the estimated value of payback period. The Pearson correlation between cost performance and payback period was -0.277 (n=172) and statistically significant ($p < 0.01$). Kendall's tau-b correlation between the two performance measures was -0.239 and also statistically significant ($p < 0.01$). This result indicates that a cost-efficient project leads to a reduced period of time required for returns to repay the original investment.

In sum, I found that there is high criterion validity between the efficiency-related performance variables evaluated by respondent's perceptions and the ultimate objective outcome variables. Although this conclusion can mitigate concerns about common method bias (CMB), I examined this issue in more concrete ways in the following section.

4.5.2 Common Method Bias

Since all the data were collected from a single source at a single point in time, CMB might be a threat to the validity of this research. In order to reduce CMB, I used a number of procedural remedies in the research design stage. Following suggestions provided by Podsakoff et al. (2003), I ensured respondents' anonymity and confidentiality of the survey. As a result, it was less likely that they would response to be more socially desirable. I also emphasized that there were no right or wrong answers. In the survey instrument, questions relating to the dependent variables were not placed near the questions for the independent variables. This procedure keeps respondents from creating cognitive correlations or cause-effect relationships among the items, thereby reducing a CMB-pattern of responses.

In the ex-post research stage, I employed a couple of statistical approaches to assess how effective the above remedies were in reducing CMB. First, I conducted Harman's single-factor tests for the two measurement models. The original CFA result for each hypothesized measurement model was compared to the result of a CFA model containing only one method factor. The chi-square difference tests indicated that the hypothesized models yielded better fits to the data than did one-factor models (For CFA in Table 4.3, $\Delta\chi^2 = 2284.949$, Δ df = 45, $p < 0.01$; For CFA in Table 4.4, $\Delta\chi^2 = 48.945$, Δ df = 1, $p<0.01$). Put differently, there was no evidence that one general method factor accounts for a majority of the covariance between items.

It is important to note that Harman's single-factor test is not sensitive enough to capture small levels of CMB (Podasakoff et al., 2003). Therefore, I relied on a more rigorous test using a marker variable. The marker variable included in the survey was a question, "I have a high level of satisfaction with my home living environment". This item was theoretically unrelated to other measures in the analysis. The lowest positive correlation between the marker variable and dependant variables was 0.019. Using the correlation value and the formula in Lindell and Whitney (2001), the entire correlations among study constructs were adjusted. Student's t-tests were conducted whether the adjusted correlations were significant or not. A comparison of the original correlations and adjusted correlations showed that the significance pattern among the constructs remained the same. Based on both ex ante and ex post approaches, I concluded that CMB is not a pervasive issue for this research.

5 ANALYSES AND RESULTS

5.1 Analyses

In order to test my hypotheses, I applied ordinary least squares (OLS) analyses. Before performing multivariate analyses, data was examined carefully in order to assure valid statistical inferences and results. Normality assumption was checked first not only for individual variables but also for composite variables (Hair, Black, Babin, Anderson, and Tatham, 2005). The normal probability plots showed that team size, specialized experience, generalized experience, and breadth of relationship are positively skewed. All of these variables are single-item measures. To accommodate this nonnormality, the four variables were transformed by taking the square root transformation and logarithm transformation. Graphical analyses of normality with Q-Q plot indicated that square root transformation is more appropriate. Table 5.1, Table 5.2, Table 5.3, and Table 5.4 present the means, standard deviations, and the correlations among the study variables.

I paid special attention to generating Table 5.3 and Table 5.4, which provide information about variables to be used in regression models that examine relational capital elements as independent variables. The regression models are supposed to use a subset of data (i.e., project samples with external partners), not the entire data. Therefore, I had to identify and assess an appropriate measurement model regarding control variables and dependent variables within the subset.

Based on the entire data, Table 4.3 (in section 4.5.1) shows the measurement model for the control and dependent variables, including TMT commitment, competence radicalness, market radicalness, time performance and cost performance. A two-group analysis was conducted to see if the same measurement model consistently holds for both the subset with external partners and the subset without external partners. First, the two groups ended up having the same path pattern with one in Table 4.3: the same indicators were dropped (IFI=0.970, NNFI=0.950, CFI=0.968, RMSEA=0.038). Next, I added constraints to examine whether the two groups have the same parameter values. Fit indices were still acceptable (IFI=0.968, NNFI=0.949, CFI=0.966, RMSEA=0.038). The standardized factor loading values were very similar to the corresponding values in Table 4.3 (the biggest difference between the paired loading values was 0.08). Since the same measurement model holds not only for the entire sample, but also for the sub-sample with external partners and the sub-sample without external partners, the same measurement items from Table 4.3 were used to come up with factor scores for TMT commitment, competence radicalness, market radicalness, time performance, and cost performance for regression analyses that include attachment and depth of relationship. In addition, the means of the control and dependent variables were not significantly different between the two groups at 95% confidence level.

After conducting OLS regression analyses, I employed several tests to examine if robust regression techniques are required. Breusch-Pagan tests showed no violation of the homoskedasticity assumption and residuals also seemed to be normally distributed (Kutner, Nachtsheim, and Neter, 2004). Cook's distance measures were calculated to identify outliers and/or data points that may distort the regression outcome (Cook, 1979). No significant outliers were detected. Therefore, I was able to accept the outcome of OLS regression analyses as efficient and unbiased.

Table 5.1 Correlations

	1. Team Size	2. R&D Spending	3. TMT Commitment	4.Competence Radicalness	5.Market Radicalness	6. Specialized Experience	7. Generalized Experience	8. Codified Knowledge	9. Disciplined Method	10.Knowledge Transfer	11. Connectedness	12.Psychological Safety	13.Breath of Relationship	14. Time Performance	15. Cost Performance
1	1														
2	.35**	1													
3	.12	.10	1												
4	.21**	.16	.05	1											
5	.26**	.23**	.09	.35**	1										
6	.26**	.11	.08	.12	.18**	1									
7	.03	-.02	-.02	.11	.01	-.18**	1								
8	.17*	.15	.17*	.03	.145*	.12	-.00	1							
9	.19**	.22**	.28**	.10	.06	.11	-.00	.26**	1						
10	.02	.12	.11	.19**	.20**	.15*	.04	.28**	.22**	1					
11	.09	-.02	.03	-.00	.05	.06	-.07	.01	.14*	-.11	1				
12	.03	-.02	.17*	-.13	.06	.10	-.10	.09	.20**	-.03	.54**	1			
13	.11	.23**	.14*	.16*	.15*	.11	.03	-.01	.21**	.17*	.13	.07	1		
14	.00	-.06	.02	-.12	-.06	-.15*	-.02	.00	.13	-.11	.07	.03	-.07	1	
15	-.24**	-.22**	-.11	-.19**	-.23**	-.05	-.06	-.12	-.02	-.17*	.13	.09	-.20**	.34**	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
Transformed data were used

Table 5.2 Descriptive statistics

	Minimum	Maximum	Mean	Std. Deviation
Team Size	2	65	9.39	8.47
R&D Spending	1.00	5.00	2.60	1.426
Top Management Team Commitment	1.00	7.00	5.22	1.299
Competence Radicalness	1.00	7.00	4.31	1.433
Market Radicalness	1.00	7.00	3.58	1.71
Specialized Experience (%)	0.00	100.00	33.89	28.05
Generalized Experience (%)	0.00	100.00	26.00	24.35
Codified Knowledge	1.00	7.00	3.79	1.414
Disciplined Methods	1.00	7.00	4.42	1.466
Knowledge Transfer	1.00	7.00	3.67	1.372
Connectedness	1.00	7.00	5.74	.953
Psychological Safety	1.00	7.00	5.69	1.020
Breadth of Relationship	0	28	2.34	4.41
Time Performance	1.00	7.00	4.41	1.614
Cost Performance	1.00	7.00	4.91	1.573

n = 212 projects.
Untransformed data were used.

Table 5.3 Correlations

	1	2	3	4	5	6	7	8	9
1. Team Size	1								
2. R&D Spending	.35**	1							
3.TMT Commitment	.17	.11	1						
4. Competence Radicalness	.23*	.26*	-.04	1					
5. Market Radicalness	.30**	.25*	.18	.37**	1				
6. Attachment	-.08	.10	.09	-.13	.13	1			
7. Depth of Relationship	.05	.13	.16	.08	.17	.17	1		
8. Time performance	-.07	-.14	-.12	-.03	.03	-.03	.14	1	
9. Cost Performance	-.27**	-.12	-.18	-.11	-.12	-.05	-.04	.35**	1

n = 104 projects with external partners.
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
Transformed data were used

Table 5.4 Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
Team Size	2.00	36.00	9.02	6.71
R&D Spending	1.00	5.00	2.662	1.501
Top Management Team Commitment	1.00	7.00	5.410	1.282
Competence Radicalness	1.00	7.00	4.42	1.46
Market Radicalness	1.00	7.00	3.60	1.74
Attachment	1.00	7.00	4.33	1.31
Depth of Relationship	1.33	7.00	5.38	1.21
Time performance	1.00	7.00	4.234	1.564
Cost Performance	1.00	7.00	4.590	1.457

n = 104 projects with external partners.
Untransformed data were used.

5.2 Results

To test the hypotheses examining whether radicalness constructs are important moderators of the relationships between intellectual capital elements and project outcomes, and whether some intellectual capital elements interact with each other, hierarchical regression analyses were performed. In the first step, only control variables were entered. I entered the main intellectual capital elements in the second step. In the third step, I entered the interactions of intellectual capital elements and project radicalness, or product terms between intellectual capital elements. All the focal predictors were mean centered to generate interaction terms (Cohen, Cohen, West, and Aiken, 2003). Variance inflation factors (VIF) were also checked to see if there was a multicollinearity problem. Based on the all the regression models, the highest VIF was 1.73, which suggests no strong multicollinearity concern.

5.2.1 Time Performance

Table 5.5 to Table 5.12 summarize the results for time performance. If an interaction effect is present, then the difference between the two R^2 values in step 2 and step 3 should be statistically significant.

Starting from competence radicalness, Model 1 in Table 5.5 shows that competence radicalness does not moderate the relationship between human capital elements (i.e., specialized experience and generalized experience) and time performance, and the relationship between structural capital elements (i.e., codified knowledge, disciplined knowledge, and knowledge transfer) and time performance. Therefore, Hypotheses 1A to 5B, Hypothesis 10A, and Hypothesis 10B are not supported.

However, the interaction between competence radicalness and connectedness is negative and significant (β = -0.392, $p < 0.01$). To plot this interaction, each variable took the value of one standard deviation below the corresponding mean to indicate low level values and one standard deviation above the mean to represent high level values (Aiken et al., 1991). The plot of the interaction is shown in Figure 5.1. Consistent with Hypothesis 6A, Figure 5.1 shows a positive relationship between connectedness and time performance when competence radicalness is low.

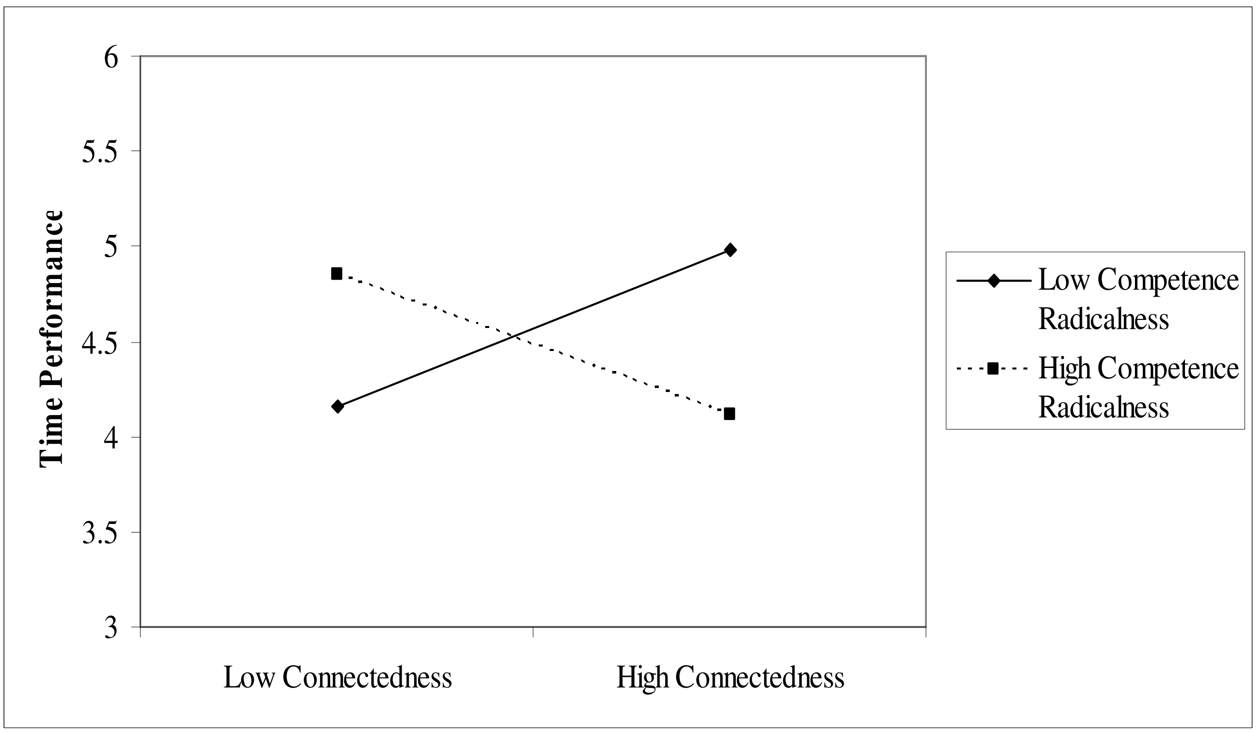

Figure 5.1 The interaction of connectedness and competence radicalness

Moreover, Figure 5.1 reveals that a team conducting a radical innovation project that requires a significant amount of learning decreases its time performance when the team members are highly connected. Hypothesis 6B proposes an inverted U-shaped relationship between connectedness and time performance of the radical projects. Researchers have modeled the concave nonlinear relationship by either adding squared variables to regression equations or using exponential functions. In this dissertation, I use the polynomial regression approach to see if the addition of higher-order terms results in significant increase in variance explained, even after the linear relationships have been taken into account (Cohen et al., 2003). Accordingly, I entered a squared term of connectedness into a regression model for only radical projects (see Table 5.8). Before doing this, I had to figure out radical projects. The data were divided into two groups, incremental project group and radical project group, based on the median value of competence radicalness, which was 4.3333. A Total of 23 sample points in the middle were dropped to get rid of indistinctive areas between the two groups. I conducted CFA of top management team commitment, radicalness, psychological safety, connectedness, time performance, and cost performance with 97 samples of radical projects. The CFA replicated the CFA result of Table 4.3 (i.e., the same measurement items were dropped) and yielded good fits with data (NNFI=0.899, CFI=0.920, IFI=0.925; 90% confidence interval for RMSEA is (0.039, 0.079)). Convergent validity, discriminant validity, and reliability of each constructs were examined and supported by data. Model 10 in Table 5.8 shows that the coefficient for the squared term of connectedness is positive and not statistically significant. The change in R^2 is not significant. Thus, Hypothesis 6B is not supported.

Model 1 in Table 5.5 also shows that that the interaction between competence radicalness and psychological safety is positive and significant ($\beta = 0.169$, $p < 0.05$). As plotted in Figure 5.2, the more project teams in a healthy psychological condition pursue radical innovation that requires much training and learning, the more they increase time performance of the projects. Accordingly, Hypothesis 7B is supported. The figure also suggests that project teams pursuing incremental innovation with a low psychological level decrease their time performance. In order to examine if there is an inverted U-shaped relationship between psychological safety and time performance of incremental projects, I entered a squared term of psychological safety into a regression model for only incremental projects. I conducted CFA of top management team commitment, radicalness, psychological safety, connectedness, time performance, and cost performance with 92 samples of incremental projects. Again, the CFA replicated the CFA result of Table 4.3 and fit the data well (NNFI=0.921, CFI=0.937, IFI=0.941; 90% confidence interval for RMSEA is (0.036, 0.077)). Convergent validity, discriminant validity, and reliability of each construct were acceptable. Model 7 in Table 5.7 shows that the coefficient for the squared term of connectedness is positive (β = 0.213) but statistically insignificant, and there is little improvement in R^2. Thus, Hypothesis 7B is not supported.

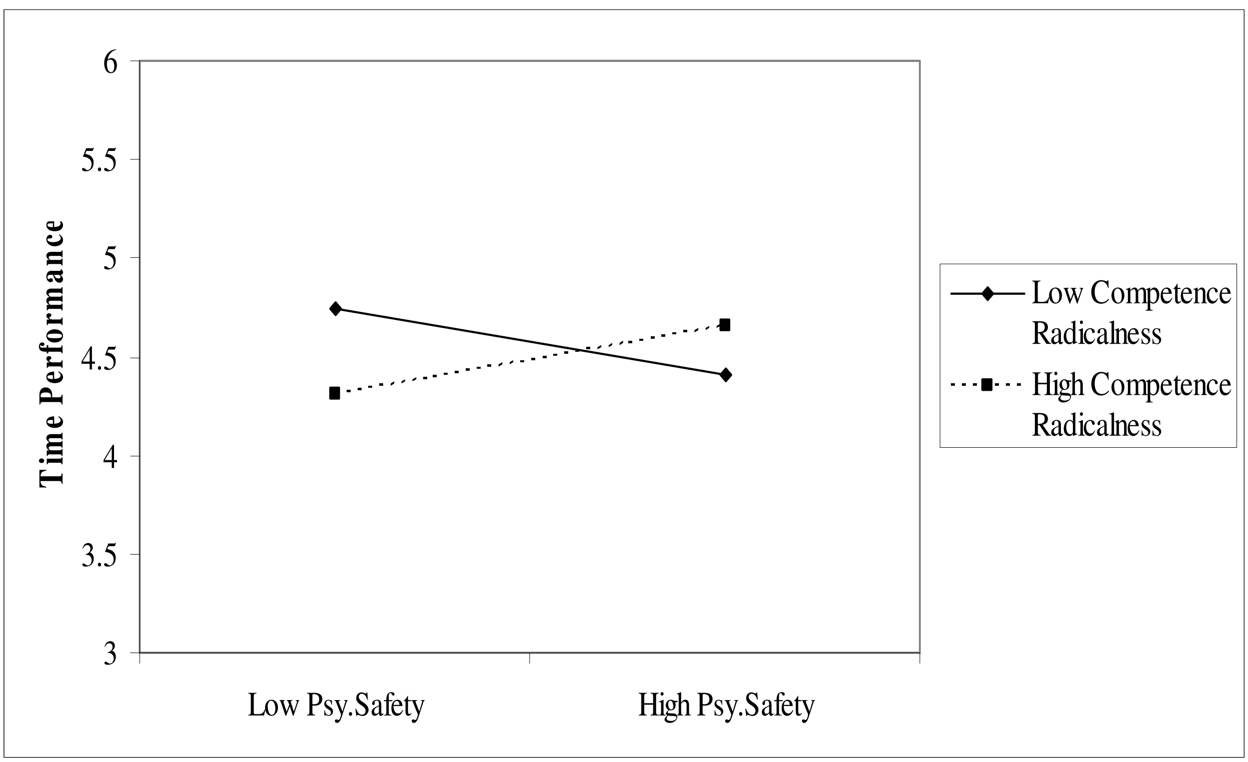

Figure 5.2 The interaction of psychological safety and competence radicalness

Table 5.5 Results of hierarchical regression analyses with competence radicalness: Effects on time performance

Independent Variables	Model 1: Pooled Data [a]			Model 2: Projects with external partners [b]		
	Step1	Step2	Step3	Step1	Step2	Step3
Step1: Controls						
Team Size	0.039	0.053	0.062	-0.021	-0.023	-0.013
R&D spend	-0.046	-0.056	-0.079	-0.105	-0.106	-0.124^{+}
TMGT commitment	0.024	0.001	-0.018	-0.105	-0.121^{+}	-0.114^{+}
Competence Radicalness	-0.124^{+}	-0.123^{+}	-0.045	-0.002	-0.010	-0.005
Step 2: Main Effects						
Specialized Experience		-0.148*	-0.155*			
Generalized Experience		-0.027	-0.018			
Codified Knowledge		0.080	0.069			
Disciplined Methods		0.190**	0.204**			
Knowledge Transfer		-0.088	-0.073			
Connectedness		0.058	0.021			
Psychological Safety		-0.041	0.001			
Breadth of relationship		-0.070	-0.070			
Attachment					-0.027	-0.019
Depth of relationship					0.091	0.102

Table 5.5 (cont'd)

Step 3: Interactions						
Competence Radicalness × Specialized Experience			-0.001			
Competence Radicalness × Generalized Experience			-0.037			
Competence Radicalness × Codified Knowledge			-0.090			
Competence Radicalness × Disciplined Methods			0.105			
Competence Radicalness × Knowledge Transfer			0.102			
Competence Radicalness × Connectedness			-0.392**			
Competence Radicalness × Psychological Safety			0.169*			
Competence Radicalness × Breadth of relationship			0.029			
Competence Radicalness × Attachment						0.278**
Competence Radicalness × Depth of relationship						-0.176*
F	0.988	1.654+	2.455**	1.432	1.226	3.277**
R^2	0.018	0.086	0.195	0.027	0.034	0.114
ΔR^2		0.068+	0.109**		0.008	0.079**

[a] n = 212 projects. Standardized regression coefficients are reported.
[b] n = 104 projects. Standardized regression coefficients are reported.
+ p <0.1; * p < 0.05; ** p < 0.01

Regarding relational capital elements, Model 2 in Table 5.5 shows that the interaction between competence radicalness and attachment of relationship is statistically significant (β = 0.278). As Figure 5.3 shows, attachment of relationship is positively related to time performance for teams that implement radical innovation projects compared to their current competences. In contrast, attachment of relationship is negatively related to time performance for teams that implement less radical, or incremental innovation projects that does not require much learning prior to the projects. These results support the opposite directions to what Hypotheses H8A and H8B stated.

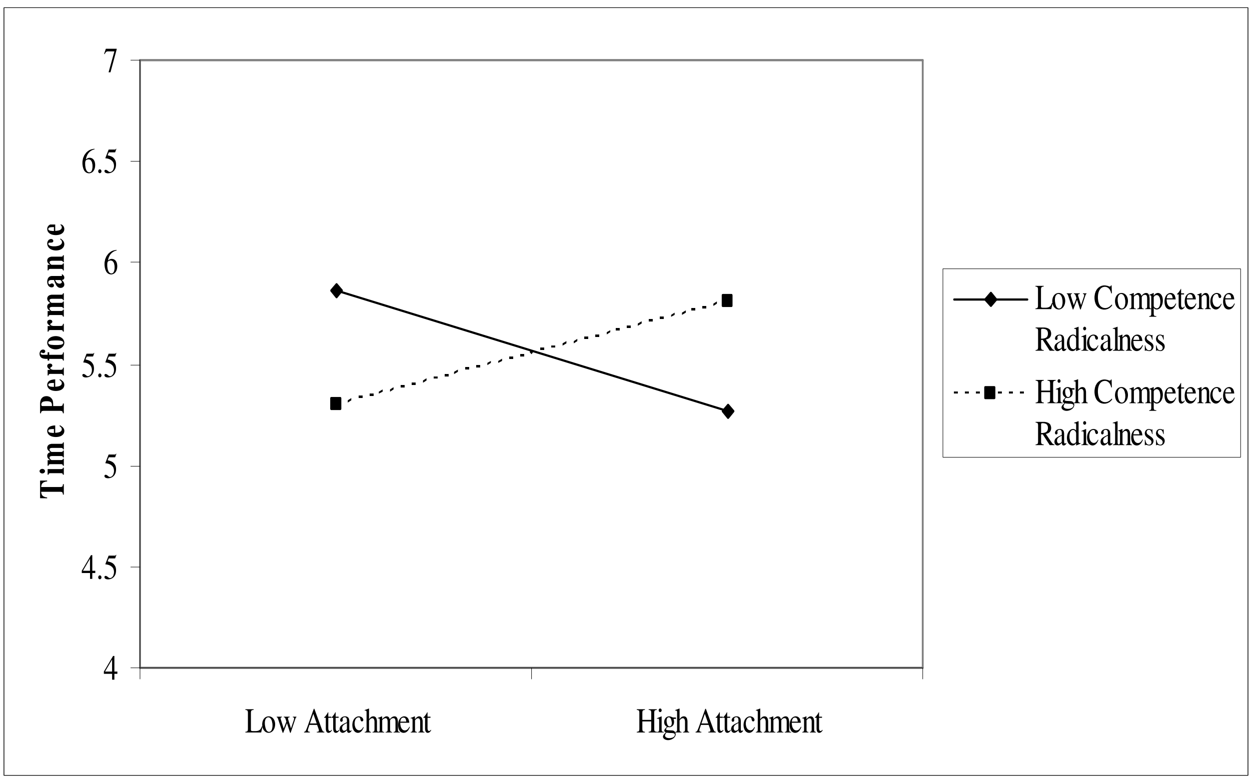

Figure 5.3 The interaction of attachment and competence radicalness

In Model 2 in Table 5.5, the interaction between competence radicalness and depth of relationship is also statistically significant at p-value = 0.05 ($\beta = -0.176$). Figure 5.4 indicates the corresponding interaction plot. Depth of relationship is positively associated with time performance when teams deal with innovation projects in which new training or learning is not necessary. However, a high level of depth of relationship with key external partners seems to delay the projects when the team members need to obtain new competences to develop products or processes. Therefore, Hypotheses H9A and H9B are supported.

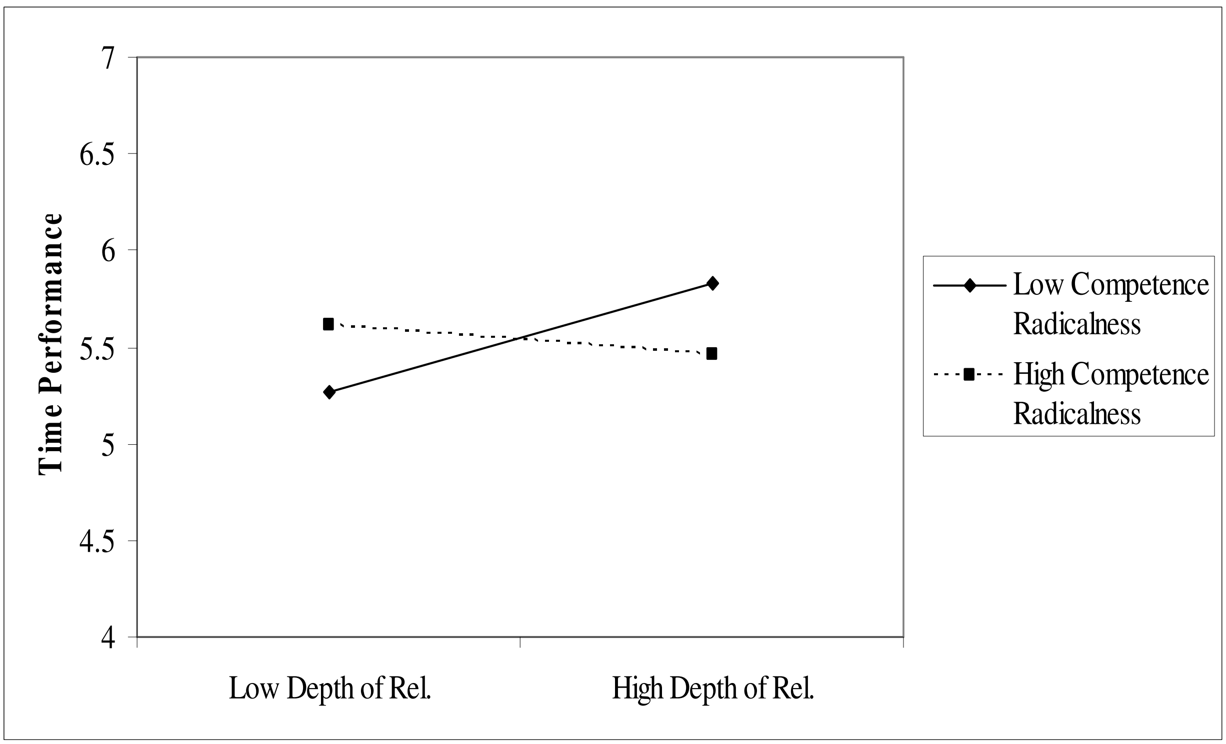

Figure 5.4 The interaction of depth of relationship and competence radicalness

Table 5.6 Results of hierarchical regression analyses with competence radicalness: Effects of three way interactions on time performance

Independent Variables	Step1	Step2	Model 3: Pooled Data [a]	Model 4: Pooled Data [a]	Model 5: Pooled Data [a]	Model 6: Pooled Data [a]
			Step3	Step3	Step3	Step3
Step1: Controls						
Team Size	0.039	0.053	0.059	0.066	0.060	0.056
R&D spend	-0.046	-0.056	-0.069	-0.059	-0.072	-0.075
TMGT commitment	0.024	0.001	-0.038	-0.007	-0.017	-0.010
Competence Radicalness	-0.124^{+}	-0.123^{+}	-0.071	-0.129^{+}	-0.096	-0.086
Step 2: Main Effects						
Specialized Experience		-0.148*	-0.149*	-0.156*	-0.140*	-0.148*
Generalized Experience		-0.027	0.013	-0.009	-0.003	-0.016
Codified Knowledge		0.080	0.098	0.106	0.089	0.086
Disciplined Methods		0.190**	0.207**	0.175*	0.207**	0.165*
Knowledge Transfer		-0.088	-0.100	-0.081	-0.097	-0.099
Connectedness		0.058	0.031	0.056	0.031	0.058
Psychological Safety		-0.041	-0.001	-0.038	-0.002	-0.074
Breadth of relationship		-0.070	-0.063	-0.074	-0.065	-0.066
Step 3: Interactions						
Competence Radicalness × Specialized Experience			0.020			
Competence Radicalness × Connectedness			-0.265**		-0.291**	
Competence Radicalness × Generalized Experience				0.022		

Table 5.6 (cont'd)

Competence Radicalness × Psy.Safety				-0.032		-0.054
Competence Radicalness × Disciplined Methods					0.085	
Competence Radicalness × Knowledge Transfer						0.053
Specialized Experience × Connectedness			0.033			
Generalized Experience × Psy. Safety				0.126		
Disciplined Methods × Connectedness					0.014	
Knowledge Transfer × Psy. Safety						0.174*
Competence Radicalness × Specialized Experience × Connectedness			0.040			
Competence Radicalness × Generalized Experience × Psy.Safety				0.094		
Competence Radicalness × Disciplined Methods × Connectedness					0.073	
Competence Radicalness × Knowledge Transfer × Psy.Safety						0.146^{+}
F	0.988	1.654^{+}	2.411**	1.608^{+}	2. 650**	1.855*
R^2	0.018	0.086	0.157	0.111	0.170	0.125
ΔR^2		0.068^{+}	0.071**	0.025	0.084**	0.039^{+}

[a] n = 212 projects. Standardized regression coefficients are reported.

$^{+}$ $p <0.1$; * $p < 0.05$; ** $p < 0.01$

To test Hypotheses 11, 12, 13, and 14, regression analyses were conducted with both pooled data and divided data. Using pooled data, as Models 3, 4, 5 and 6 in Table 5.6 directly show, I examined if the interactions among intellectual capital elements affect time performance differently according to the level of competence radicalness of innovation projects. None of the tree-way interactions in Table 5.6 were statistically significant, indicating that the moderating effect of competence radicalness on the relationship between a specified intellectual capital element and time performance would not differ depending on another specified intellectual capital element in each hypothesis.

Using divided data allows me to examine the interactions among intellectual capital elements within specific innovation project groups more directly. Model 8 in Table 5.7 shows that the interaction between connectedness and specialized experience is not statistically significant (β = - 0.042), and does not support Hypothesis 11. As shown in Model 11 in Table 5.8, the coefficient for the product term of generalized experience and psychological safety is positive (β = 0.173) but not statistically significant. Accordingly, Hypothesis 12 is not supported. Results in Model 9 in Table 5.7 shows that the interaction between disciplined methods and connectedness does not affect time performance significantly, since the coefficient is insignificant (β = 0.042). Therefore, Hypothesis 13 is not supported. Finally, as shown in Model 12 in Table 5.8, the coefficient of interaction between knowledge transfer and psychological safety is statistically significant (β = 0.289) and the change in R^2 value is also significant. Nevertheless, F-test shows that Model 12 does not explain a meaningful amount of variance in the time performance of radical projects (F-value 1.488 is not statistically significant); thus Hypothesis 14 is not supported.

Table 5.7 Results of hierarchical regression analyses with competence radicalness: Effects on time performance within incremental projects

Independent Variables	Step1	Model 7: H7A [a]		Model 8: H11 [a]		Model 9: H13 [a]	
		Step2	Step3	Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	0.142	0.159	0.142	0.132	0.135	0.117	0.117
R&D spend	-0.186	-0.196^{+}	-0.191	-0.138	-0.145	-0.180	-0.177
TMGT commitment	-0.029	-0.019	-0.036	-0.025	-0.019	-0.057	-0.056
Step 2: Main Effects							
Specialized Experience				-0.185^{+}	-0.184^{+}		
Disciplined Methods						0.060	0.040
Connectedness				0.166	0.160	0.174	0.166
Psychological Safety		-0.080	0.090				
Psychological Safety squared			0.213				
Step 3: Interactions							
Specialized Experience × Connectedness					-0.042		
Disciplined Methods × Connectedness							0.042
F	1.027	0.902	1.054	1.805	1.516	1.212	1.020
R^2	0.034	0.040	0.058	0.095	0.097	0.066	0.067
ΔR^2				0.061^{+}	0.002	0.032	0.001

[a] n = 92 incremental projects. Standardized regression coefficients are reported. $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 5.8 Results of hierarchical regression analyses with competence radicalness: Effects on time performance within radical projects

Independent Variables	Step 1	Model 10:H6B [a]		Model 11: H12 [a]		Model 12: H14 [a]	
		Step2	Step 3	Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	-0.055	-0.043	-0.022	-0.053	-0.037	-0.056	-0.051
R&D spend	-0.036	-0.045	-0.066	-0.036	-0.044	-0.026	-0.056
TMGT commitment	0.096	0.088	0.096	0.091	0.097	0.105	0.096
Step 2: Main Effects							
Generalized Experience					-0.149		
Psychological Safety					0.042	0.022	-0.038
Knowledge Transfer						-0.080	-0.168
Connectedness		-0.139^{+}	-0.083				
Connectedness squared			0.123				
Step 3: Interactions							
Generalized Experience × Psychological Safety					0.173		
Knowledge Transfer ×Psychological Safety							0.289**
F	0.389	0.750	0.808	0.247	0.673	0.359	1.488
R^2	0.012	0.032	0.042	0.013	0.043	0.019	0.090
ΔR^2		0.019	0.011	0.001	0.029	0.007	0.070**

[a] n = 97 radical projects. Standardized regression coefficients are reported. $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

I replicated the whole series of regression analyses with respect to market radicalness instead of competence radicalness. Model 1 in Table 5.9 shows that none of the interaction terms between market radicalness and intellectual capital elements are significant. Therefore, Hypotheses 1A to 6A, Hypothesis 7B, Hypothesis 10A, and Hypothesis 10B are not supported. The squared term of connectedness is not significant in Model 10 in Table 5.12, does not result in a significant change in R^2 value, and thus does not support H6B. Model 7 in Table 5.11 indicates that the square term of psychological safety is marginally significant but the entire model is nonsignificant. Therefore, H7A is not supported.

Model 2 in Table 5.9 examines how market radicalness moderates the relationship between relational capital elements and time performance. The interaction term between market radicalness and attachment is not statistically significant, and thus does not support H8A and H8B. However, the interaction term between market radicalness and depth of relationship increases R^2 value significantly (β = - 0.224). Figure 5.5 shows that a high level of collaboration with external partners to improve current products or processes may expedite the entire projects. On the other hand, when the projects aim to introduce totally new technology to the market, the in-depth external collaboration would delay the projects. Therefore, H9A and H9B are supported.

In Table 5.10, all the three-way interaction terms are not significant in the pooled data. More direct analyses were conducted after dividing the data into two groups, based on the median value of market radicalness, which was 3.6667. In Models 8 and 9 in Table 5.11, none of the interaction terms of intellectual capital elements are significant, thereby not supporting Hypothesis 11 and 13. Although the interaction between knowledge transfer and psychological safety is marginally significant in Model 12 in Table 5.12 (β = - 0.224, p-value <0.098), F-test indicates that the entire model is not statistically meaningful. In Model 11, the interaction between generalized experience and psychological safety is not significant. The model is not significant. As a result, both Hypotheses 12 and 14 are not supported.

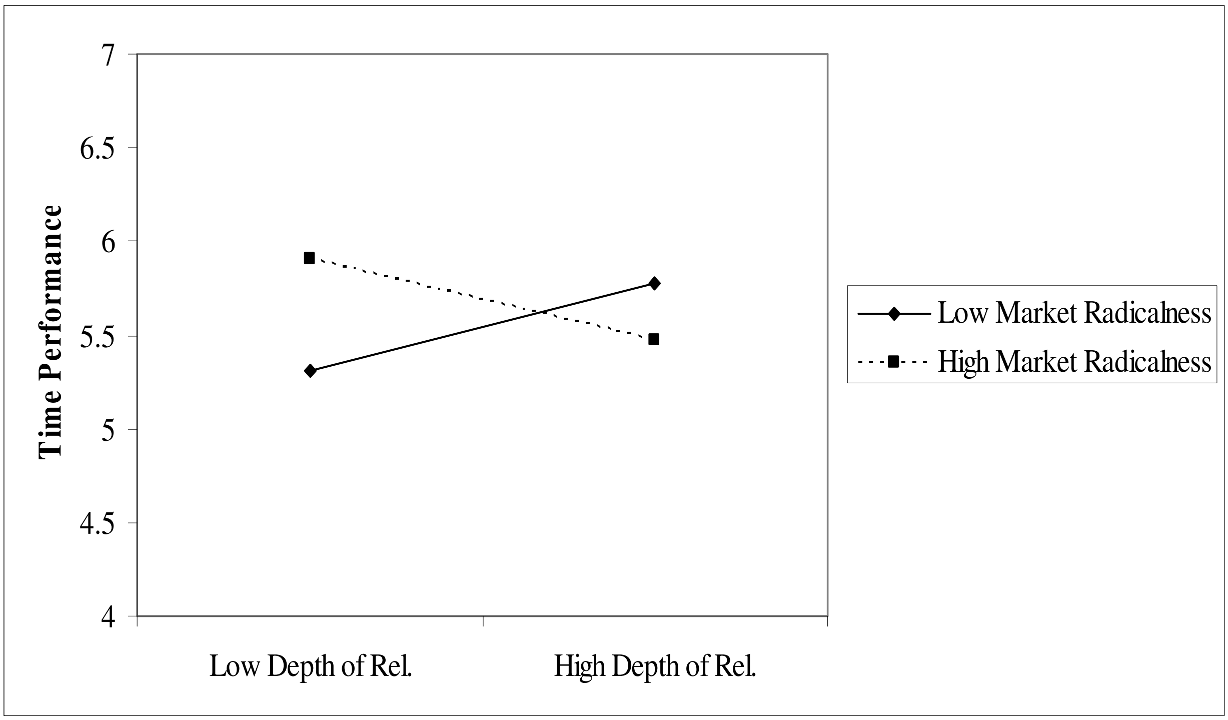

Figure 5.5 The interaction of depth of relationship and market radicalness

Table 5.9 Results of hierarchical regression analyses with market radicalness: Effects on time performance

Independent Variables	Model 1: Pooled Data [a]			Model 2: Projects with external partners [b]		
	Step1	Step2	Step3	Step1	Step2	Step3
Step1: Controls						
Team Size	0.030	0.031	0.055	-0.043	-0.046	-0.014
R&D spend	-0.048	-0.052	-0.085	-0.116	-0.115	-0.104
TMGT commitment	0.024	0.002	-0.000	-0.116^{+}	-0.127^{+}	-0.142*
Market Radicalness	-0.061	-0.013	-0.002	0.086	-0.080	0.072
Step 2: Main Effects						
Specialized Experience		-0.155*	-0.170*			
Generalized Experience		-0.039	-0.021			
Codified Knowledge		0.002	0.037			
Disciplined Methods		0.188*	0.150^{+}			
Knowledge Transfer		-0.105	-0.110			
Connectedness		0.059	0.002			
Psychological Safety		-0.025	-0.006			
Breadth of relationship		-0.066	-0.020			
Attachment					-0.034	-0.033
Depth of relationship					0.082	0.007

Table 5.9 (cont'd)

Step 3: Interactions						
Market Radicalness × Specialized Experience			-0.056			
Market Radicalness × Generalized Experience			-0.003			
Market Radicalness × Codified Knowledge			0.009			
Market Radicalness × Disciplined Methods			-0.153			
Market Radicalness × Knowledge Transfer			-0.005			
Market Radicalness × Connectedness			-0.119			
Market Radicalness × Psychological Safety			0.039			
Market Radicalness × Breadth of relationship			0.086			
Market Radicalness × Attachment						0.052
Market Radicalness × Depth						-0.224**
F	0.342	1.282	1.097	1.790	1.424	2.199*
R^2	0.007	0.072	0.103	0.033	0.040	0.079
ΔR^2		0.065^{+}	0.031		0.007	0.040*

[a] n = 212 projects. Standardized regression coefficients are reported.
[b] n = 104 projects. Standardized regression coefficients are reported.
$^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 5.10 Results of hierarchical regression analyses with market radicalness: Effects of three way interactions on time performance

Independent Variables	Step1	Step2	Model 3: Pooled Data [a]	Model 4: Pooled Data [a]	Model 5: Pooled Data [a]	Model 6: Pooled Data [a]
			Step3	Step3	Step3	Step3
Step1: Controls						
Team Size	0.030	0.031	0.040	0.038	0.056	0.057
R&D spend	-0.048	-0.052	-0.066	-0.066	-0.084	-0.071
TMGT commitment	0.024	0.002	-0.011	-0.010	-0.007	-0.016
Market Radicalness	-0.061	-0.013	0.005	-0.022	-0.013	-0.029
Step 2: Main Effects						
Specialized Experience		-0.155*	-0.182*	-0.164*	-0.167*	-0.150*
Generalized Experience		-0.039	-0.041	-0.027	-0.024	-0.044
Codified Knowledge		0.002	0.021	0.012	0.028	-0.001
Disciplined Methods		0.188*	0.179*	0.193*	0.141^{+}	0.198*
Knowledge Transfer		-0.105	-0.111	-0.112	-0.120	-0.109
Connectedness		0.059	0.032	0.056	0.008	0.034
Psychological Safety		-0.025	-0.016	-0.000	0.013	-0.008
Breadth of relationship		-0.066	-0.047	-0.061	-0.025	-0.067
Step 3: Interactions						
Market Radicalness × Specialized Experience			-0.054			
Market Radicalness × Connectedness			-0.135		-0.107	
Market Radicalness × Generalized Experience				-0.005		

Table 5.10 (cont'd)

Market Radicalness × Psy.Safety				-0.055		-0.019
Market Radicalness × Disciplined Methods					-0.148^{+}	
Market Radicalness × Knowledge Transfer						-0.001
Specialized Experience × Connectedness			0.089			
Generalized Experience × Psy. Safety				0.101		
Disciplined Methods × Connectedness					0.083	
Knowledge Transfer × Psy. Safety						0.075
Market Radicalness × Specialized Experience × Connectedness			0.032			
Market Radicalness × Generalized Experience × Psy.Safety				-0.062		
Market Radicalness × Disciplined Methods × Connectedness					0.054	
Market Radicalness × Knowledge Transfer × Psy.Safety						0.115
F	0.342	1.282	1.185	1.158	1.142	1.311
R^2	0.007	0.072	0.089	0.087	0.104	0.097
ΔR^2		0.065^{+}	0.017	0.015	0.032	0.025

[a] n = 212 projects. Standardized regression coefficients are reported. $^{+}$ p <0.1; * p < 0.05; ** p < 0.01

Table 5.11 Results of hierarchical regression analyses with market radicalness: Effects on time performance within incremental projects

Independent Variables	Step1	Model 7: H7A [a]		Model 8: H11 [a]		Model 9: H13 [a]	
				Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	-0.024	-0.009	0.009	0.001	0.001	-0.061	-0.060
R&D spend	0.015	0.006	0.002	0.017	0.018	-0.033	-0.036
TMGT commitment	0.053	0.063	0.026	0.061	0.056	0.003	0.005
Step 2: Main Effects							
Specialized Experience				-0.141	-0.137		
Disciplined Methods						0.264**	0.263**
Connectedness				0.056	0.089	0.012	0.008
Psychological Safety		-0.079	0.092				
Psychological Safety squared			0.235^{+}				
Step 3: Interactions							
Specialized Experience × Connectedness					0.077		
Disciplined Methods × Connectedness							0.016
F	0.105	0.238	0.771	0.490	0.495	1.525	1.263
R^2	0.003	0.009	0.034	0.022	0.027	0.065	0.066
ΔR^2		0.006	0.031	0.019	0.005	0.063*	0.000

[a] n = 112 incremental projects. Standardized regression coefficients are reported. $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 5.12 Results of hierarchical regression analyses with market radicalness: Effects on time performance within radical projects

Independent Variables	Step 1	Model 10:H6B [a]		Model 11: H12 [a]		Model 12: H14 [a]	
		Step2		Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	0.137	0.136	0.131	0.132	0.132	0.131	0.139
R&D spend	-0.135	-0.135	-0.131	-0.131	-0.131	-0.130	-0.145
TMGT commitment	0.001	0.001	-0.011	-0.017	-0.017	-0.010	-0.014
Step 2: Main Effects							
Generalized Experience				0.052	0.052		
Psychological Safety				0.093	0.093	0.076	-0.003
Knowledge Transfer						-0.078	-0.051
Connectedness		- 0.036	- 0.073				
Connectedness squared			-0.144				
Step 3: Interactions							
Generalized Experience × Psychological Safety					0.000		
Knowledge Transfer ×Psychological Safety							0.194^{+}
F	0.818	0.638	0.673	0.687	0.566	0.741	1.097
R^2	0.026	0.027	0.036	0.036	0.036	0.039	0.068
ΔR^2		0.01	0.01	0.011	0.000	0.013	0.029^{+}

[a] n = 97 radical projects. Standardized regression coefficients are reported. $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

5.2.2 Cost Performance

Table 5.13 to Table 5.20 show the regression results for cost performance. Starting from competence radicalness, Model 1 in Table 5.13 shows that competence radicalness moderates only the relationship between specialized experience and cost performance. Therefore, Hypotheses H2A to H7B, Hypotheses H10A and H10B are not supported with respect to cost performance. None of the squared terms in Model 7 in Table 5.15 and Model 10 in Table 5.16 are statistically insignificant nor result in significant improvement in R^2. Therefore, H6B and H7A are not supported.

Model 1 in Table 5.13 also shows that the interaction between competence radicalness and specialized experience is positive and statistically significant ($\beta = 0.192$, $p < 0.01$). The plot of the interaction is shown in Figure 5.6. Contrary to my prediction, the figure indicates a positive relationship between specialized experience and cost performance when project teams pursue radical innovation projects that require a large amount of learning. It also reveals that teams decrease their cost performance when a majority of team members are specialists, and they conduct incremental innovation projects which can be covered by current competences. These results supported the opposite directions to what Hypotheses H1A and H1B predicted.

Model 2 in Table 5.13 shows that competence radicalness changes neither the relationship between attachment and cost performance, nor the relationship between depth of relationship and cost performance. Therefore, Hypotheses H8A, H8B, H9A, and H9B are not supported.

Table 5.13 Results of hierarchical regression analyses with competence radicalness: effects on cost performance

Independent Variables	Model 1: Pooled Data [a]			Model 2: Projects with external partners [b]		
	Step1	Step2	Step3	Step1	Step2	Step3
Step1: Controls						
Team Size	-0.173*	-0.201**	-0.216**	-0.223*	-0.230*	-0.233*
R&D spend	-0.105	-0.084	-0.058	-0.010	-0.003	-0.001
TMGT commitment	-0.073	-0.077	-0.097	-0.149*	-0.141*	-0.152*
Competence Radicalness	-0.136*	-0.117	-0.101	-0.063	-0.071	-0.073
Step 2: Main Effects						
Specialized Experience		0.044	0.088			
Generalized Experience		-0.014	0.007			
Codified Knowledge		-0.076	-0.079			
Disciplined Methods		0.097	0.129^{+}			
Knowledge Transfer		-0.118^{+}	-0.128^{+}			
Connectedness		0.118	0.102			
Psychological Safety		0.012	0.013			
Breadth of relationship		-0.163*	-0.169*			
Attachment					-0.071	-0.074
Depth of relationship					0.043	0.039

Table 5.13 (cont'd)

Step 3: Interactions						
Competence Radicalness × Specialized Experience			0.192**			
Competence Radicalness × Generalized Experience			0.066			
Competence Radicalness × Codified Knowledge			0.013			
Competence Radicalness × Disciplined Method			0.116^{+}			
Competence Radicalness × Knowledge Transfer			0.026			
Competence Radicalness × Connectedness			-0.081			
Competence Radicalness × Psychological Safety			-0.060			
Competence Radicalness × Breadth of relationship			-0.023			
Competence Radicalness × Attachment						-0.066
Competence Radicalness × Depth of Relationship						0.034
F	5.620**	3.292**	2.941**	5.369*	3.776	2.936
R^2	0.093	0.158	0.225	0.094	0.199	0.103
ΔR^2		0.065*	0.067*		0.005	0.004

[a] n = 212 projects. Standardized regression coefficients are reported.
[b] n = 104 projects. Standardized regression coefficients are reported.
[+] $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

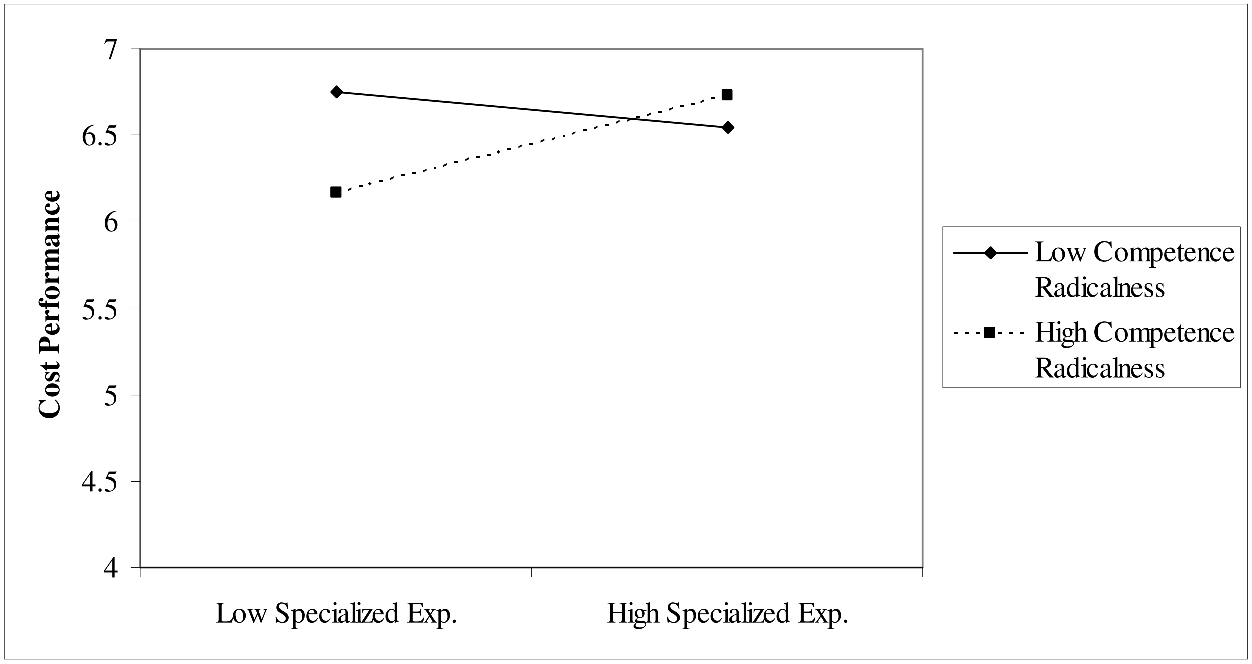

Figure 5.6 The interaction of specialized experience and competence radicalness

To test Hypotheses 11, 12, 13, and 14 regarding interactions among intellectual capital elements, I conducted regression analyses with both pooled data and divided data. Using pooled data, Model 3, 4, 5 and 6 in Table 5.14 test if the interactions affect cost performance differently along with different levels of competence radicalness. None of the three-way interaction terms were statistically significant. Based on divided data which consist of two groups of innovation projects, I directly tested Hypotheses 11, 12, 13, and 14 using interaction terms among intellectual capital elements. Model 8 in Table 5.15 shows that the coefficient of the interaction between connectedness and specialized experience is negative and statistically significant (β = -0.221). The change in R^2 value was also significant. Figure 5.7 demonstrates the significant interaction between specialized experience and connectedness, which occurs when team members are conducting innovation projects that do not demand new competences or skills. The figure shows that the specialized experience of a team negatively influences cost performance when the team members are highly connected. On the contrary, it appears that there is a positive relationship between specialized experience and cost performance when the team members are weakly connected. Therefore, the opposite direction to what Hypotheses 11 suggested is supported.

As shown in Model 11 in Table 5.16, the coefficient for the product term of generalized experience and psychological safety is positive (β = 0.031) but not statistically significant. Accordingly, Hypothesis 12 is not supported. Results in Model 9 in Table 5.15 shows that the interaction between disciplined methods and connectedness does not affect cost performance significantly, since the coefficient is insignificant (β = -0.163). Therefore, Hypothesis 13 is not supported. Finally, as shown in Model 12 in Table 5.16, the coefficient of interaction between knowledge transfer and psychological safety is significant (β = -0.175). However, the increase in R^2 value is marginally significant (p = 0.096). Therefore, Hypothesis 14 is not supported well.

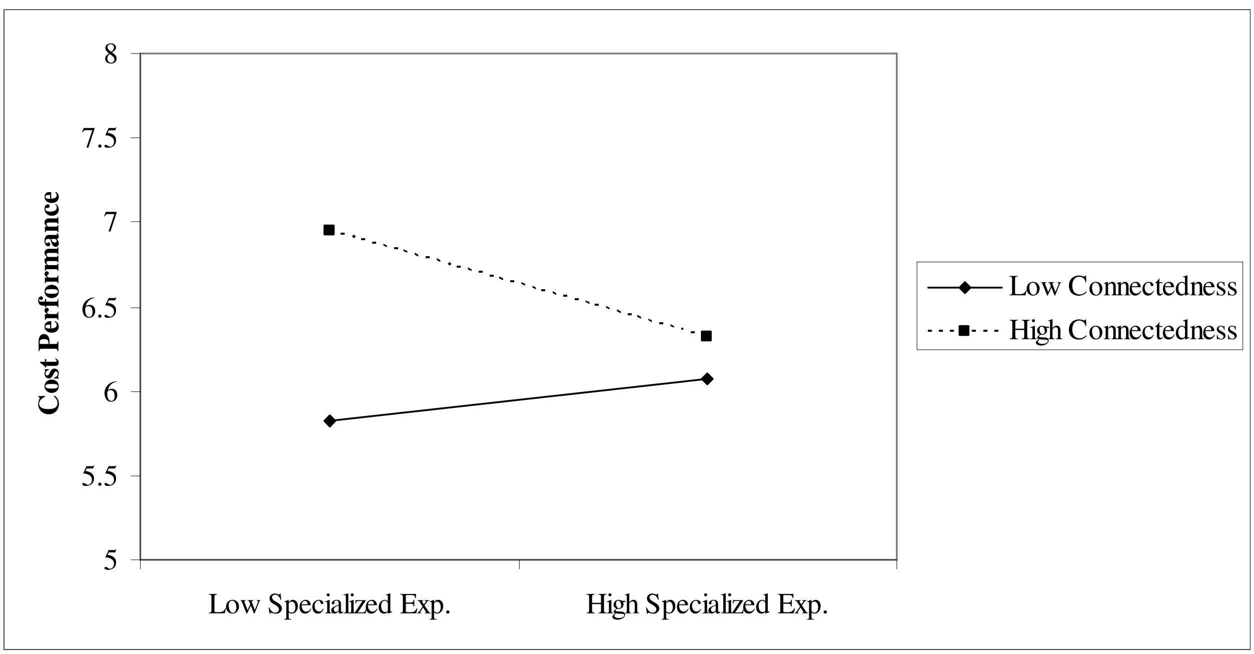

Figure 5.7 Interaction effect of specialized experience and connectedness within incremental innovation projects that have a low level of competence radicalness

Table 5.14 Results of hierarchical regression analyses with competence radicalness: Effects of three way interactions on cost performance

Independent Variables	Step1	Step2	Model 3: Pooled Data [a]	Model 4: Pooled Data [a]	Model 5: Pooled Data [a]	Model 6: Pooled Data [a]
			Step3	Step3	Step3	Step3
Step1: Controls						
Team Size	-0.173*	-0.201**	-0.196**	-0.212**	-0.199**	-0.218**
R&D spend	-0.105	-0.084	-0.084	-0.077	-0.088	-0.076
TMGT commitment	-0.073	-0.077	-0.096	-0.085	-0.072	-0.086
Radicalness	-0.136*	-0.117	-0.085	-0.085	-0.123+	-0.112
Step 2: Main Effects						
Specialized Experience		0.044	0.063	0.052	0.058	0.046
Generalized Experience		-0.014	0.010	-0.002	-0.008	-0.002
Codified Knowledge		-0.076	0.065	-0.086	0.072	-0.087
Disciplined Methods		0.097	0.143*	0.089	0.124+	0.112
Knowledge Transfer		-0.118+	-0.143*	-0.110	-0.117+	-0.104
Connectedness		0.118	0.097	0.096	0.111	0.102
Psychological Safety		0.012	0.015	0.020	0.011	0.065
Breadth of relationship		-0.163*	-0.161*	-0.162*	-0.158*	-0.152*
Step 3: Interactions						
Competence Radicalness × Specialized Experience			0.194**			
Competence Radicalness × Connectedness			-0.097		-0.132+	
Competence Radicalness × Generalized Experience				0.058		

Table 5.14 (cont'd)

Competence Radicalness × Psy.Safety				-0.061		-0.068
Competence Radicalness × Disciplined Methods					0.109	
Radicalness × Knowledge Transfer						0.119
Specialized Experience × Connectedness			-0.056			
Generalized Experience × Psy. Safety				-0.049		
Disciplined Methods × Connectedness					-0.057	
Knowledge Transfer × Psy. Safety						-0.95
Competence Radicalness × Specialized Experience × Connectedness			0.077			
Competence Radicalness × Generalized Experience × Psy.Safety				0.058		
Competence Radicalness × Disciplined Methods × Connectedness					0.059	
Competence Radicalness × Knowledge Transfer × Psy.Safety						-0.110
F	5.620**	3.292**	3.557**	2.697**	2.957**	2.874**
R^2	0.093	0.158	0.216	0.172	0.186	0.182
ΔR^2		0.065*	0.058**	0.015	0.028	0.024

[a] n = 212 projects. Standardized regression coefficients are reported. $^+$ p <0.1; * p < 0.05; ** p < 0.01

Table 5.15 Results of hierarchical regression analyses with competence radicalness: Effects on cost performance within incremental projects

Independent Variables	Step1	Model 7: H7A [a]		Model 8: H11 [a]		Model 9: H13 [a]	
		Step 2	Step 3	Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	-0.069	-0.131	-0.125	-0.115	-0.098	-0.123	-0.120
R&D spend	-0.161	-0.127	-0.128	-0.117	-0.153	-0.125	-0.139
TMGT commitment	-0.072	-0.108	-0.102	-0.077	-0.045	-0.037	-0.041
Step 2: Main Effects							
Specialized Experience				-0.097	-0.095		
Disciplined Methods						-0.112	-0.034
Connectedness				0.376**	0.345**	0.375**	0.406**
Psychological Safety		0.280**	0.222				
Psychological Safety squared		-0.073	-0.073				
Step 3: Interactions							
Specialized Experience × Connectedness					-0.221*		
Disciplined Methods × Connectedness							-0.163
F	1.471	3.018*	2.434*	4.237**	4.565**	4.276**	3.979**
R^2	0.048	0.122	0.124	0.198	0.244	0.199	0.219
ΔR^2		0.074**	0.002	0.150**	0.046*	0.151**	0.020

[a] n = 112 incremental projects. Standardized regression coefficients are reported. $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 5.16 Results of hierarchical regression analyses with competence radicalness: Effects on cost performance within radical projects

Independent Variables	Step1	Model 10: H6B [a]		Model 11: H12 [a]		Model 12: H14 [a]	
		Step2	Step 3	Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	-0.339**	-0.343**	-0.346**	-0.338**	-0.335**	-0.338**	-0.341**
R&D spend	-0.053	-0.050	-0.047	-0.048	-0.050	-0.041	-0.025
TMGT commitment	-0.062	-0.059	-0.060	-0.076	-0.075	-0.058	-0.053
Step 2: Main Effects							
Generalized Experience				0.035	0.034		
Psychological Safety				0.776	0.078	0.070	0.106
Knowledge Transfer						-0.090	-0.036
Connectedness		0.046	0.038				
Connectedness squared			-0.017				
Step 3: Interactions							
Generalized Experience × Psy. Safety					0.031		
Knowledge Transfer ×Psy. Safety							-0.175*
F	4.810**	3.632**	2.879*	3.002*	2.493*	7.124**	6.979**
R^2	0.134	0.136	0.137	0.142	0.143	0.148	0.174
ΔR^2		0.002	0.000	0.007	0.001	0.014	0.026^{+}

[a] n = 97 radical projects. Standardized regression coefficients are reported. $^{+}$ p <0.1; * p < 0.05; ** p < 0.01

When it comes to market radicalness which might moderate the relationships between intellectual capital elements and cost performance, none of hypotheses were supported since the corresponding interaction terms and higher order term are neither statistically significant nor resulting in a meaningful increase in R^2 values (See Table 5.17, 5.18, 5.19 and 5.20). Table 5.21 summarizes the overall findings, indicating which hypotheses are supported by data with respect to which dependent variables.

Finally, following Cohen (Cohen, 1992), I examined whether the sample size for each multiple regression model in this dissertation is large enough to have at least a power level of 0.8. Among the models that use pooled data, Model 1 is the biggest one, including 20 predictors. I assumed p-value, or type 1 error rate as 0.05. To achieve power of 0.8 and a medium effect size (f^2=0.15), a sample size of 156 is required. The original sample size was 212 and much bigger than the required size. Model 2 which examines relational capital elements uses projects with external partners. Following the same procedures, I found that a sample size of 108 is required. 104 samples were actually used and this sample size is acceptable. Among the models that use the group of radical innovation projects, Models 11 and 12 are the biggest ones, including 6 predictors. Among the models that use the group of incremental innovation projects, Models 8 and 9 are the baggiest models and also include 6 predictors. Power calculation reveals that a sample size of 97 is required for them. 97 samples were used in Models 11 and 12, while 92 samples (in case of work radicalness) or 112 samples (in case of market radicalness) were used for Models 8 and 9. Taken together, I concluded that the sample size for each regression model was large enough to have an acceptable degree of statistical power.

Table 5.17 Results of hierarchical regression analyses with market radicalness: Effects on cost performance

Independent Variables	Model 1: Pooled Data [a]			Model 2: Projects with external partners [b]		
	Step1	Step2	Step3	Step1	Step2	Step3
Step1: Controls						
Team Size	-0.162*	0.189**	0.200**	-0.227**	-0.236**	-0.263**
R&D spend	-0.095	-0.064	-0.089	-0.017	-0.013	-0.003
TMGT commitment	-0.067	0.067	-0.078	-0.140*	-0.139*	-0.135^{+}
Market Radicalness	-0.166*	-0.137	-0.121	0.028	-0.023	-0.011
Step 2: Main Effects						
Specialized Experience		-0.050*	-0.054			
Generalized Experience		-0.023	-0.014			
Codified Knowledge		0.063	-0.039			
Disciplined Methods		0.096*	0.109			
Knowledge Transfer		-0.095	-0.095			
Connectedness		0.120	0.042			
Psychological Safety		-0.036	-0.112			
Breadth of relationship		-0.159*	-0.134^{+}			
Attachment					-0.055	-0.057
Depth of relationship					0.021	0.017

Table 5.17 (cont'd)

Step 3: Interactions						
Market Radicalness × Specialized Experience			-0.056			
Market Radicalness × Generalized Experience			-0.003			
Market Radicalness × Codified Knowledge			0.009			
Market Radicalness × Disciplined Methods			-0.153			
Market Radicalness × Knowledge Transfer			-0.005			
Market Radicalness × Connectedness			-0.119			
Market Radicalness × Psychological Safety			0.039			
Market Radicalness × Breadth of relationship			0.086			
Market Radicalness × Attachment						-0.072
Market Radicalness × Depth						0.018
F	5.798**	3.278**	2.351**	5.208**	3.562**	2.298**
R^2	0.101	0.165	0.198	0.091	0.094	0.103
ΔR^2		0.064^+	0.032		0.003	0.009

[a] n = 212 projects. Standardized regression coefficients are reported.
[b] n = 104 projects. Standardized regression coefficients are reported.
$^+$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 5.18 Results of hierarchical regression analyses with market radicalness: Effects of three way interactions on cost performance

Independent Variables	Step1	Step2	Model 3: Pooled Data [a]	Model 4: Pooled Data [a]	Model 5: Pooled Data [a]	Model 6: Pooled Data [a]
			Step3	Step3	Step3	Step3
Step1: Controls						
Team Size	-0.162*	-0.189**	-0.189**	-0.198**	-0.177*	-0.199**
R&D spend	-0.095	-0.064	-0.073	-0.082	-0.067	-0.075
TMGT commitment	-0.067	0.067	-0.048	-0.077	-0.074	-0.099
Market Radicalness	-0.166*	-0.137	0.147*	-0.130^{+}	-0.153^{+}	-0.135^{+}
Step 2: Main Effects						
Specialized Experience		-0.050*	-0.039	-0.051	-0.038	0.051
Generalized Experience		-0.023	-0.037	-0.014	-0.022	-0.004
Codified Knowledge		0.063	-0.037	-0.042	-0.058	-0.030
Disciplined Methods		0.096*	0.095	0.114	0.102	0.119
Knowledge Transfer		-0.095	-0.120	-0.095	-0.095	-0.078
Connectedness		0.120	0.034	0.058	0.098	0.049
Psychological Safety		-0.036	-0.021	0.097	0.033	0.104
Breadth of relationship		-0.159*	-0.143^{+}	-0.137^{+}	-0.138^{+}	-0.129^{+}
Step 3: Interactions						
Market Radicalness × Specialized Experience			-0.018			
Market Radicalness × Connectedness			-0.006		-0.057	
Market Radicalness × Generalized Experience				-0.042		
Market Radicalness × Psy.Safety				-0.174*		-0.168*
Market Radicalness × Disciplined Methods					-0.061	

Table 5.18 (cont'd)

Market Radicalness × Knowledge Transfer						-0.014
Specialized Experience × Connectedness			-0.081			
Generalized Experience × Psy. Safety				-0.043		
Disciplined Methods × Connectedness					-0.052	
Knowledge Transfer × Psy. Safety						-0.105
Market Radicalness × Specialized Experience × Connectedness			0.143^{+}			
Market Radicalness × Generalized Experience × Psy.Safety				-0.013		
Market Radicalness × Disciplined Methods × Connectedness					0.062	
Market Radicalness × Knowledge Transfer × Psy.Safety						0.084
F	5.798**	3.278**	2.820**	2.976**	2.564**	3.093**
R^2	0.101	0.165	0.188	0.196	0.174	0.202
ΔR^2		0.064^{+}	0.017	0.023	0.009	0.037^{+}

[a] n = 212 projects. Standardized regression coefficients are reported. $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 5.19 Results of hierarchical regression analyses with market radicalness: Effects on cost performance within incremental projects

Independent Variables	Step1	Model 7: H7A [a]		Model 8: H11 [a]		Model 9: H13 [a]	
		Step2	Step3	Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	0.045	0.009	0.020	0.010	0.010	0.001	-0.001
R&D spend	-0.098	-0.077	-0.080	-0.078	-0.079	-0.083	-0.064
TMGT commitment	-0.070	-0.094	-0.115	-0.074	-0.070	-0.080	-0.091
Step 2: Main Effects							
Specialized Experience				-0.024	-0.027		
Disciplined Methods						0.026	0.035
Connectedness				0.180^{+}	0.155	0.175	0.200*
Psychological Safety		0.177^{+}	0.276*				
Psychological Safety squared			0.137				
Step 3: Interactions							
Specialized Experience × Connectedness					-0.059		
Disciplined Methods × Connectedness							-0.090
F	0.495	1.217	1.173	0.988	0.871	0.990	0.956
R^2	0.013	0.042	0.051	0.043	0.046	0.043	0.050
ΔR^2		0.029	0.009	0.030	0.003	0.030	0.007

[a] n = 112 incremental projects. Standardized regression coefficients are reported. $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 5.20 Results of hierarchical regression analyses with market radicalness: effects on cost performance within radical projects

Independent Variables	Step 1	Model 10:H6B [a]		Model 11: H12 [a]		Model 12: H14 [a]	
		Step2	Step3	Step2	Step3	Step2	Step3
Step1: Controls							
Team Size	-0.309**	-0.317**	-0.327**	-0.314**	-0.304**	-0.318**	-0.311**
R&D spend	-0.075	-0.075	-0.067	-0.068	-0.074	-0.066	-0.081
TMGT commitment	-0.242*	-0.240*	-0.264**	-0.262**	-0.252**	-0.238*	-0.261**
Step 2: Main Effects							
Generalized Experience				-0.007	-0.005		
Psychological Safety				0.161^{+}	-0.224	0.145	0.072
Knowledge Transfer						-0.091	-0.066
Connectedness		- 0.108*	- 0.024				
Connectedness squared			-0.275^{+}				

Table 5.20 (cont'd)

Step 3: Interactions							
Generalized Experience × Psychological Safety					-0.408		
Knowledge Transfer ×Psychological Safety							0.178
F	6.867**	6.298**	5.963**	4.746**	4.392**	4.964**	4.708**
R^2	0.181	0.215	0.247	0.207	0.227	0.214	0.239
ΔR^2		0.034*	0.032$^+$	0.025	0.020	0.033	0.025$^+$

[a] n = 97 radical projects. Standardized regression coefficients are reported.

$^+$ p <0.1; * p < 0.05; ** p < 0.01

Table 5.21 The summary of results

Intellectual Capital Dimensions	Intellectual Capital Elements	Incremental Innovation Performance	Results • Competence Radicalness: * • Market Radicalness:**	Radical Innovation Performance	Results • Competence Radicalness: * • Market Radicalness:**
Human Capital	Specialized Experience	H1A: +	Cost* (Opposite)	H1B: -	Cost* (Opposite)
	Generalized Experience	H2A: -		H2B: +	
Structural Capital	Codified Knowledge	H3A: +		H3B: -	
	Disciplined Methods	H4A: +		H4B: -	
	Knowledge Transfer	H5A: -		H5B: +	
Social Capital	Connectedness	H6A: +	Time*	H6B: ∩	Time* (Negative)
	Psychological Safety	H7A: ∩	Time*(Negative)	H7B: +	Time*
Relational Capital	Attachment of Relationship	H8A: +	Time* (Opposite)	H8B: -	Time* (Opposite)
	Depth of Relationship	H9A:+	Time*,**	H9B: -	Time*,**
	Breadth of Relationship	H10A: -		H10B: +	
Interactions of Intellectual Capital Elements	Connectedness × Specialized Experience	H11: +	Cost* (Opposite)		
	Psychological Safety × Generalized Experience			H12: +	
	Disciplined Methods × Connectedness	H13: -			
	Knowledge Transfer × Psychological Safety			H14: -	

6 DISCUSSION

Faced with the rising importance of knowledge-related resources to develop a sustainable competitive advantage (Menor et al., 2007; Nonaka, 1991), organizations must understand how to conceptualize and utilize such resources. Knowledge resources are stored in various forms - employees' expertise, institutionalized information and routines, social relationships among employees, and networks with external partners. The term 'intellectual capital' collectively refers to the knowledge resources and emphasizes the value of them as a main source of organizational wealth and compatibility. Despite the growing recognition of the importance of intellectual capital, organizations experience difficulties in identifying, managing, and extracting real value from it due to its tacit nature (Berry, 2004; Brooking, 1997). Moreover, across different academic fields, there has been lack of agreement regarding which elements, taken together, make up intellectual capital (Marr, 2005). Responding to these challenges, this dissertation theoretically elaborates and empirically delves into four key dimensions of intellectual capital, including human capital, structural capital, social capital and relational capital.

The main interest of this study is maximizing the performance of innovation projects. In order to create and maintain competitive advantage over time, organizations should be good at implementing incremental innovation and radical innovation to the same extent (Benner and Tushman, 2003; Jansen et al., 2006). However, the two types of innovation require different kinds of learning and knowledge management patterns. Accordingly, organizations must find appropriate ways to leverage each intellectual capital element for different types of innovation projects. Using a combination of survey data collected from members of the Corptech database and the SME database, this study provides empirical evidence that the radicalness of an innovation project moderates the relationship between certain intellectual capital elements of a project and the performance of that project with respect to efficiency.

6.1 Theoretical Implications

This dissertation extends the extant literature about intellectual capital in several ways.

6.1.1 Empirical Verification of Intellectual Capital Elements

This dissertation integrates research on intellectual capital across different academic boundaries. To date, each discipline has emphasized its own specific intellectual capital elements. The focus varies in line with different perspectives on the source of profits (i.e., customer satisfaction, human resource management, accounting, software application, supplier management, etc.). However, no research examines whether the elements can be differentiated from each other and be treated as independent factors or should be combined to represent the same research variable in order to explain an organization's performance. If the scales from different academic fields, taken together, do not show good convergent and discriminant properties under a common research context, then the scales should be either combined or modified to establish ones that come across academic boundaries. Addressing this problem, my research underscores that structural capital elements, i.e., codified knowledge, disciplined methods, and knowledge transfer, and social capital elements, i.e., connectedness and psychological safety, are not only theoretically, but also empirically distinguishable.

Regarding structural capital, codified knowledge has been studied in knowledge management literatures, as a stored reference for effective knowledge application to enhance organizational performance (Alavi and Leidner 2001). The existence of explicit knowledge, however, does not fully address the extent to which innovation activities are effectively directed by formal coordination mechanisms, such as disciplined methods. Moreover, codified knowledge and disciplined methods are mainly internally focused, and therefore do not account for learning that occurs when project team members incorporate knowledge from sources outside the team to respond to unexpected disruptive changes. The explicit knowledge, formal procedures to manage innovation projects, and learning routines to acquire new knowledge are equally important elements of structural capital of the firm, but have been rarely studied together.

With regard to social capital, both connectedness and psychological safety concern social linkages among project team members. Unlike the structural capital elements, connectedness and psychological safety have been discussed as informal mechanisms that influence team members' willingness to cooperate to enhance innovation project performance (Choo et al., 2007, Jansen et al., 2006, Nahapiet and Ghoshal 1998). A problem is that they have not been distinguished clearly in the related literature; therefore, the relationship between the two constructs has been unclear. This research provides empirical evidence that the density of the project team's social network (i.e., connectedness) and the psychological quality of social network (i.e., psychological safety) are different concepts. Moreover, the effects of the two constructs on time performance are different. Connectedness positively influences the time performance of incremental projects and negatively influences that of radical projects, which is the opposite of the results from psychological safety.

In sum, the literature is strengthened because this dissertation shows that structural capital and social capital elements suggested by different academic fields are distinguishable theoretically as well as empirically, despite possible cognitive associations among them. Future research should discuss the elements as distinct factors that collectively address not only available knowledge itself, but also effective knowledge management processes which incorporate knowledge acquisition, knowledge transfer, knowledge application and knowledge creation.

6.1.2 Examination of Project Radicalness as a Moderator

This dissertation also advances an understanding of the influence of radicalness of an innovation project on the relationship between intellectual capital and project performance. There is a widely-held belief that knowledge-related resources are generally beneficial to achieve optimal performance of innovation projects. However, the results in this dissertation demonstrate that whether intellectual capital elements enhance or deteriorate the project performance depends on the extent to which a project is radical. In order to discuss project radicalness, I incorporated two different types of radicalness from the previous literature, including competence radicalness and market radicalness. The empirical evidence in this dissertation supports the conclusion that the two concepts are distinguishable not only theoretically but also empirically. There has been not much research which examines the two project radicalness constructs at the same time.

When teams conduct innovation projects which do not demand much training to obtain new skills or knowledge, I found they may increase their time performance by pursuing a higher level of connectedness. Project teams can expedite the overall project through direct contacts among team members to discuss emergent issues (Jaworski and Kohli 1993). In addition, by easily accessing information and knowledge that other individuals have, project teams can develop trust in the relationships among their members (Adler and Clark, 1991). Based on trust, a reciprocal outflow of information also grows within the social networks (Burt, 1992). As a result, project teams enjoy increased amounts of knowledge available for innovation activities.

Strong ties among members facilitate transfer of complex information about current products or processes (Hansen, 1999). In this way, a high level connectedness helps fast problem solving for incremental innovation.

If teams pursue radical innovation which requires much efforts to obtain new knowledge or skills, increasing direct contacts among team members appears to have a negative effect, not an inverted U-shaped effect, on time performance. Weak ties (i.e., a low level of connectedness) contribute to the search for new information or ideas (Hansen, 1999). On the other hand, strong ties (i.e., a high level of connectedness) create strong norms among team members, thereby restricting the opportunity to explore new ideas (Rowley, Behrens, and Krackhardt, 2000). The dense social interactions at the early stage of a project may limit the possible scope of new competences necessary for the project, thereby increasing development time. I could not find the evidence that an optimal level of connectedness exists to improve time performance. When team members are involved in radical innovation that challenges internal work skills, the disadvantage of redundant ideas or information from a dense social network appears to outweigh the advantages of less efforts of obtaining new information due to the network.

Competence radicalness moderates the relationship between time performance and psychological safety (which is another social capital element) in a different way. My research suggests that a high level of psychological safety reduces the time to complete radical innovation projects which require new competences. Without feeling any threats of punishment or judgment by others, team members can propose and explore many alternatives to solve problems in the early stages of an innovation project (MacDuffie, 1997). The more alternatives promoted by psychological safety, the faster the members come up with effective solutions to change dramatically current products and processes dramatically. In contrast, my research suggests that increased levels of the psychological safety of team members could be detrimental to time performance if current competences are enough to complete the project. Psychological safety allows team members to experiment with new techniques and ideas. In an incremental innovation project that does not challenge team members' abilities and does not require new approaches to implement it, the lack of authority to direct innovation activities and possible failures that result from the experimentation merely delay the entire project.

This dissertation also demonstrates that the effect of the attachment of a relationship with a key external partner on time performance is changed by competence radicalness. The prediction as to how project radicalness moderates the relationship between attachment and time performance was not clear in the literature. I found that a high level of attachment with external partners contributes to reducing the completion time for radical innovation projects that demand new competences. Transaction cost economics, resource based view, and social capital theory collectively contend that a commitment to a long-term relationship can reduce opportunism among partners, promote investments for mutual resources, and thus facilitate sharing of critical knowledge and information. The promoted interorganizational collaboration for radical innovation speeds up the entire project. This result provides additional support for research on supply chain management, which asserts that performance improvement is possible only when partners in a supply chain commit to long-term relationships with each other (e.g., Krause et al. 2007). However, my dissertation also reveals that a higher level of attachment with external partners could delay incremental innovation projects. When a project does not challenge current competence within a team, the team might not need other information sources, such as external ties, to obtain and learn non-redundant knowledge or new competences, thereby expediting the entire project. Moreover, it takes time not only to develop but also to maintain external social ties

(Hansen, Podolny, and Pfeffer, 2001). Then, the time investments for external relationships simply dominate time savings that come from the relationships.

Both competence radicalness and market radicalness moderate the association between depth of relationship and time performance in a similar way. Given incremental innovation projects, a high level of collaboration with key external partners subsequently decreases project time. Suppliers generally have more comprehensive knowledge regarding critical parts or components, while customers provide valuable ideas about how to improve poor design (Tsai, 2009). Therefore, when teams want to improve current products or processes, collaborating with external partners can provide appropriate competences and knowledge to reach problem solving and decision consensus much faster (Koufteros et al. 2007, Petersen et al., 2005). Given radical innovation projects, however, my finding underlines the dangers of working with the external partners too much. When teams want to develop totally new products or processes by using new technology that has never been used in the industry, existing partners are likely to have no expertise in the technology either. Training and educating the partners would become necessary in order to work with them. Then, the entire project will be slowed down without any benefits of obtaining new knowledge from the external partners. When project teams do not have appropriate internal skills to implement a project, they may find it difficult to understand and integrate ideas from the communication with external partners. As a result, a large amount of time will be wasted. Similarly, Tsai (2009) asserts that organizations should have a high level of absorptive capacity to gain the benefit of external collaboration for NPD. However, this finding may seem to be against what Song and Di Bebedetto (2008) argue. The authors argue that greater supplier involvement will increase the performance of new products from radical innovation in terms of gross margin and sales growth. Since the authors focus on the context of NPD in new venture and their dependent variables are different from those in this dissertation, it is difficult to conclude that my finding does conflict with what Song and Di Bebedetto (2008) found. Therefore, future research should examine more various dependent variables and contexts to make a clearer picture regarding how project radicalness moderates the relationship between depth of relationship and project performance.

A moderating effect of competence radicalness on the relationship between specialized experience and cost performance is surprising. Grounded on search-behavior theories, Hypotheses 1A and 1B anticipated that specialized experience has a positive effect on the performance of incremental innovation projects, while having a negative effect on the performance of radical innovation projects. Nevertheless, my data support the opposite relationships with respect to cost performance. This may be understood in the following ways: Specialized experience in a specific task area is a main source of the productivity in innovation (Narayanan et al., 2009). By focusing on a single or few functional tasks over different innovation projects, specialists can obtain tacit knowledge, which makes their particular jobs much easier. When implementing radical innovation projects that challenge team members' competencies and require learning of new knowledge, specialists would be able to understand and assimilate the knowledge better than others due to their higher level of skills and knowledge of the most recent technological developments in a given field. As a result, specialists could apply the new knowledge to product or process development with less effort (Cohen and Levinthal 1990). The increased productivity by specialists in project teams could reduce the entire project costs. However, this interpretation of the relationship between specialized experience and cost performance under radical innovation does not mean that the specialized knowledge from past experience necessarily contributes to the generation of new ideas or a broad search for new competences. Here, I conclude that the benefit of cost-saving using specialists could dominate any inefficiency due to their in-depth search behaviors.

On the other hand, specialists could increase the total cost of projects when teams pursue incremental innovation that does not require much learning. In this situation, specialized knowledge accumulated from past experience can be applied to current tasks without severe adjustment (Narayanan et al., 2009). Not many specialists in the same functional areas would be needed as long as specialists included in the teams have related experience from similar projects in the past. Rather, codified knowledge or disciplined methods could provide useful references for incremental innovation. Technical specialists are usually expensive labor. Therefore, it is understandable that innovation teams that employ many specialists tend to spend more money throughout the projects. Again, this interpretation does not imply that specialists actually participate in a broad search for problem solving, which inhibits incremental innovation. The above explanations about the relationship between specialized experience and cost performance under a specific type of innovation are not against the underlying theoretical logic of Hypotheses 1A and 1B. Put differently, the results do not corroborate Hypotheses 1A and 1B, but do not falsify them either. Accordingly, future research should further examine other dependent variables that are more directly associated with search behaviors of team members. It would then be possible to check if contradictory results regarding cost performance are just an artifact of the productivity effects of specialists or reflect the real world phenomena. A good example of such dependent variables would be the number of new products developed, the number of new processes developed, or the number of new design characteristics (e.g., Katila and Ahuja 2002). Many new features of products or processes developed directly describe a broad search pattern of team members, while the presence of many similar features indicates a in-depth search pattern for them.

Overall, these findings provide substantial support for the recent theoretical argument about ambidexterity, namely that organizations should employ different management mechanisms for incremental innovation and radical innovation (e.g., Benner and Tushman 2003, Jansen et al., 2006). Empirical research on this issue has been limited primarily to structural capital elements, such as process management programs, to see whether they have different effects on the two types of innovation. My dissertation strengthens the literature by showing that the focus should be extended to human capital, social capital, and relational capital elements.

6.1.3 Inconsistent results with different outcome variables and different moderators

My findings reveal that the moderating effects of project radicalness constructs are not consistent across two outcome variables. The impacts of social capital elements (i.e., psychological safety and connectedness) and relational capital elements (i.e., attachment of relationship and depth of relationship) on time performance were significantly moderated by competence radicalness. However, this is not the case with respect to cost performance. The impacts of social and relational capital elements on cost performance remain the same for both radical and incremental projects. On the other hand, competence radicalness significantly changes the impact of a human capital element (i.e., specialized experience) on cost performance, but not on time performance. When it comes to market radicalness, depth of relationship is the only intellectual capital element that influences time performance differently in response to different levels of project radicalness.

These results imply two things. First, future related research should examine the performance of innovation projects more carefully. In most cases, researchers use performance measures which evaluate together time, cost, technical performance, and overall satisfaction. But this dissertation suggests that the combined measures for project performance could distort the underlying dynamism between intellectual capital elements and project radicalness. In order to properly address how to leverage intellectual capital for an innovation project, researchers need to elaborate the different kinds of performance measures in detail. My findings indicate that social capital and relational capital should be carefully managed to improve time performance, while the management of human capital becomes critical if the main interest is cost performance.

Second, competence radicalness moderates the relationship between intellectual capital and project performance in a different way from market competence. The moderating role of competence radicalness applies to not only internal human and social capital, but also to external relationship capital elements. However, market radicalness as a moderator matters only when project teams collaborate with external key partners. Put differently, competence radicalness seems to have more moderation effects than market radicalness. Team members may not need to participate in learning to obtain new knowledge when their project aims to introduce new concept of products or processes to the market by capitalizing on competences at hand. In contrast, a project that challenges current competences might directly motivate team members' learning or their attitude towards learning and developing new competences. So the magnitude of both in-depth search and broad search of members might be intensified and the contributions of intellectual capital elements to the two different search behaviors become more apparent. I encourage future research to examine the two types of project radicalness together to justify this assertion.

6.1.4 Interactions among intellectual capital elements

I also found a possible interactive relationship between connectedness and specialized experience. I initially hypothesized that connectedness moderates the relationship between specialized experience and incremental innovation performance (see Hypothesis 11). The initial prediction was that specialists within a team would be connected to amplify their expertise's positive impact on an innovation project that does not demand new competences. However, my data show that specialized experience actually increases cost performance of incremental innovation under a low level of connectedness (see Figure 5.7). Recalling the result for Hypothesis 1A, having an excessive number of technical specialists would be costly for incremental innovation. The specialists might not need to directly communicate with each other since the nature of incremental innovation projects does not require the adoption or integration of new knowledge or information from others. Therefore, additional costs to maintain dense social networks simply increase project costs for incremental innovation without increasing productivity of the specialists further. A way to avoid such increased costs may be to establish an independent work environment by eliminating unneeded connections among team members as the number of specialists within the team increases. Although it has often been theorized that intellectual capital elements interact to influence innovation performance (e.g., Subramaniam and Youndt, 2005), my dissertation underscores the value of examining the interactions carefully. I found that the dynamisms are not easy to predict with extant literature, leading me to conclude that this is an important area for future empirical examination.

6.2 Managerial Implications

My dissertation has many practical implications for conducting innovation projects. The role of knowledge-related resources is thought to be essential to a firm's survival. However, very little research has adopted a comprehensive view of the resources, i.e., intellectual capital, and has clarified how organizations should utilize them through incremental innovation and radical innovation. Existence of knowledge or information within a firm is not enough to account for the success of innovation activities. Instead, it is the ability to leverage intellectual capital appropriately that generates real values (Berry, 2004; Edvinsson and Sullivan, 1996), since changing the nature of projects is much more difficult.

My results indicate that practitioners first need to identify available intellectual capital elements, and then align some of them according to project-specific situations. If a project requires to adopt new competencies or to develop new markets, all of the following factors would help accelerate the project: psychological safety among team members who are not densely connected; long-term relationships with external partners; and in-depth interactions with the partners would propel the project. In order to enhance psychological safety, team leaders should show signs of benevolence and treat other team members with respect (Siemsen et al., 2009). Team leaders should also emphasize the importance of cooperative lenses, rather than competitive lenses, to view other team members (Edmonson 1999). In order to enhance the quality of relationships with external partners, managers should evaluate different characteristics of different partners (i.e., with respect to commitment, technical competences, culture, etc.) before selecting suitable ones (Petersen et al., 2005, Tsai, 2009). On the other hand, when a project demands to adjust current products or processes using competencies at hand, practitioners can rely on the following factors for fast progress on the project: dense networks for establishing direct contacts; a centralized team culture without a high level of autonomy; and impromptu relationships with external partners.

In addition, my results also demonstrate that having many technical specialists could be a cost-effective strategy for radical innovation that challenges internal competences. Although specialists may not contribute to a broad search for problem solving, the increased productivity due to their abilities to understand and apply new knowledge might outweigh their inabilities to generate new ideas. I suggest that managers should identify new technology to be adopted for radical innovation before putting their efforts into team-building. Much money would be saved because specialists can then focus on their tasks without being distracted by the demand of a broad search or explorative learning. In other words, for incremental innovation that does not challenge internal competences, constructing a team with many specialists may waste money. Structural capital could replace specialized human capital when the explicit and institutionalized knowledge from previous projects includes enough information for similar projects. Therefore, managers should consider managerial mechanisms to collect and store specialized knowledge as reference or institutional asset for future innovation activities. Nevertheless, under the condition when team members are not connected well, a large portion of specialists could reduce total costs of incremental innovation projects. In this situation, communication and discussion would not easily occur to solve the emerging problems. Therefore, specialists who have expertise to solve the problems by themselves could save a big amount of money more so generalists who require collaboration with people for innovation activities,.

Finally, when we take into account project radicalness, including competence radicalness and market radicalness, informal intellectual capital elements (i.e., social capital and relational capital elements) appear to have more significant roles in predicting project performance than formal intellectual capital elements (i.e., structural capital elements). Accordingly, practitioners should be interested in building the appropriate informal intellectual capital according to different types of innovation projects. It takes a tremendous amount of time and effort to build social and relational capital. Therefore, I suggest for practitioners to prepare multiple subgroups within an organization which have different characteristics regarding the two informal intellectual capital dimensions, and to select particular groups for a particular innovation project as need arises. This recommendation is consistent with what ambidexterity literature argues is needed to achieve both exploration and exploitation (e.g. Benner and Tushman 2003).

The executive summary for survey respondents delineates the above recommendations (See Appendix). In order to obtain reactions from industry people, I interviewed with two additional project managers in different companies via telephone. Both of them generally agreed with the results of my study and some of their comments provide richer insights into results herein and future research direction.

Both managers were involved in innovation projects which had a high level of competence radicalness, but a relatively low level of market radicalness. Nevertheless, their perspectives on codified knowledge and knowledge transfer were different. One manager mentioned that experienced workers in his company tend to be overloaded since people involved in even different projects often bring unsolved problems back to the workers to get some help. In this case, establishing codified knowledge seems to be critical. However, the other managers put much emphasis on knowledge transfer over codified knowledge. He said that since technologies for his company's product change so fast, there is no need to keep past knowledge in the database. Rather, inviting third-parties and having seminars to learn new technology trend is more important. These comments suggest that future research should study “the velocity of technical change in the market” as another key contextual factor to characterize an innovation project’s radicalness.

Both managers also mentioned that they would always put the competence of external partners above the length of relationship when they have to select external partners for their radical innovation projects. Since they don’t have enough knowledge or skills to implement the projects, it is the partner’s competence that they can depend on. Although the managers expressed agreement with the notion that old friends are more likely to share information, it does not necessarily means that the old friends actually provide beneficial information for radical innovation, Having said that, future research should control the level of external partners’ knowledge level about new technologies to clarify the impacts of relational capital elements on different innovation projects.

7 LIMITATIONS AND FUTURE RESEARCH DIRECTION

There are several limitations to this dissertation that I want to acknowledge. These limitations suggest meaningful directions for future research. First, with the exception of human capital elements, all of the intellectual capital elements and performance constructs relied on respondents' perceptions. Although I found no strong evidence of CMB and although performance measures were significantly related to objective measures, future research may consider a longitudinal research design to better assess how the impact of intellectual capital elements on the performance of innovation is influenced by project radicalness. Putting a time separation between measurements of independent variables and those of dependent variables would be a good approach. Getting multiple responses for a project can likewise mitigate this problematic issue.

Second, hypotheses regarding generalized experience were not supported. I am afraid that the current measure - the percentage of team members that had a wide range of knowledge spanning multiple task areas, yet had limited specialized expertise in any given area - might not capture a team's flexible human capital that contributes to a broad search for problem solving. Rather than experiences in other task areas, experiences in other business units, companies, or industries might better explain the broad search behavior of team members. Future research should develop and examine theses measures.

Third, hypotheses regarding structural capital elements were not supported by data. In his meta-analysis, Damanpour's (1991) concludes that the impact of disciplined methods (in the paper, the author used the term "formalization") on innovation is not moderated by project radicalness, which is consistent with my finding. As far as I know, however, there is no empirical research that examines whether codified knowledge and knowledge transfer should be managed differently depending upon the type of innovation. My results suggest that teams do not need to control the two structural capital elements differently in response to different levels of project radicalness. These findings may challenge common beliefs about project management in the literature on innovation. Being cautious in making any conclusion, I encourage researchers to study the same questions under various research settings. For my dissertation, data were drawn from many manufacturing-related industries in the U.S., which makes it possible to discuss results in this dissertation as generalizable theories. Nevertheless, focusing on a specific industry would better mitigate possible confounding effects due to industry characteristics, such as environmental competitiveness. This approach could rule out some alternative explanations about the results, increasing the validity of research implications.

Fourth, hypotheses regarding breadth of relationship were not supported, which could be due to the problem of measurement. Related research suggests another way to calculate this breadth of relationship variable. Rather than simply counting the number of external partners directly involved in an innovation project, it might be important to standardize the measure since the size of the total network available for each firm could vary (Lechner, Frankenberger, and Floyd, 2010). In order to get the standardized value, future research should additionally ask the maximum number of external ties used in a similar project in the past.

There are at least two valuable avenues for future research. First, researchers should examine other project performance measures to elaborate the complex role of intellectual capital in innovation activities. This dissertation mainly focused on efficiency-related measures, including cost performance and time performance. Cost performance has been a main concern for every business to increase profitability. Time performance attracted much attention as short time-to-market became critical to enjoy the first-mover advantages. However, recent research started looking at knowledge-related outcome variables. The basic premise is that in order to adapt to rapid environmental changes, employees need to be good at knowledge management and learning. For example, motivations to share knowledge (Siemsen et al., 2009) and the amount of knowledge created (2007) would be important dependent variables to explain the success of a firm or its innovation activities. Learning or knowledge creation might be possible at the expense of time or cost. Therefore, many different and interesting implications would be obtained if future research examines how intellectual capital elements influence the knowledge-related outcome variables.

The intellectual capital concept enables researchers to examine the ambidexterity issue in a more systematic way. Different subgroups that support different innovation activities within an organization can be characterized with respect to the intellectual capital elements suggested in this dissertation, including human resources, formal mechanisms, and informal mechanisms of a firm. Examining to what extent subgroups carry different types of intellectual capital could give a clue to whether the company is striking the balance between exploration and exploitation to ensure a competitive advantage over time.

APPENDIX

APPENDIX: Executive Summary

Michigan State University Innovation Project Survey

This report provides a framework to identify knowledge-related resources that teams in organizations can utilize for their innovation projects. Furthermore, we discuss how team-leaders manage those resources appropriately in response to different types of innovation projects. Recommendations are based on the analysis of 212 product/process innovation projects that had been completed in 2009 and 2010 in the U.S. Data were obtained from a wide range of industries, including manufacturing, software publisher, and professional, scientific and technical services.

Overview

Innovation is becoming crucial for any organization's survival under the current fierce, dynamic, and competitive environment. Successful innovation requires the ability to develop new products or processes in better, cheaper, and faster ways.

It is a common belief that knowledge-related resources play a critical role in enhancing the performance of innovation projects. Nevertheless, according to Accenture's 2003 survey of CEOs, practitioners experience difficulties in identifying and managing knowledge resources for different types of innovation projects (see http://www.accenture.com/NR/rdonlyres/1027B239-BFB8-4FE0-AE58-A95898046978/0/fva_summary.pdf).

Key Issue 1. What knowledge-related resources can be utilized for innovation projects?

Knowledge resources are stored in various forms within organizations. Innovation project managers can identify and evaluate the valuable intellectual assets across the following four dimensions:

- Human capital
    - Knowledge that resides in employees

    - Examples: employees' skills, experiences, problem solving abilities, creativities, etc.
- Structural capital
    - Institutionalized and codified knowledge captured by organizations
    - Examples: databases, patents, manuals, information systems, managerial procedures/routines, etc.
- Social capital
    - Knowledge embedded within the networks of mutual acquaintance and recognition among employees
    - Examples: network ties, cultures, trust, shared codes within a firm, etc.
- Relational Capital
    - Knowledge embedded in the relationships or networks with external partners including customers, suppliers, universities, or private consulting groups.
    - Examples: long-term relationships with external partners, cooperative relationships with external partners, the number of external partners available, etc.

Key Issue 2. Which knowledge-related resources will support innovation projects?

Although each knowledge-related resource may be considered to be valuable in any innovation project, one size does not fit all. Different projects have different project goals. Therefore, managers should understand the detailed relationships between specific knowledge resources and specific outcome measures.

Table 1 briefly summarizes the results of our analysis, identifying the resources that were significantly related to performance in the innovation projects we studied. In our research, four performance outcomes were examined, including time, cost, knowledge created, and technical achievement.

- *Time performance*: adherence to schedule
- *Cost performance*: adherence to original budget

- *Knowledge performance*: the degree to which doing the innovation project enhanced the team's abilities and yielded much knowledge to perform future work
- *Technical performance*: the degree to which the project led to higher quality, better technical performance, and meeting customers' need better than competing products/processes

Table 1. Positive impacts of knowledge-related resources on the performance of innovation projects

		Time	Cost	Knowledge Created	Technical Achievement
Human Capital	Specialists				
	Generalists				
Structural Capital	Codified knowledge				✓
	Disciplined Methods	✓	✓		
Social Capital	Connectedness		✓	✓	
	Psychological Safety			✓	
Relational Capital	Long-term relationship with external partners			✓	
	Collaboration with external partners			✓	✓
	# of external partners				✓

Findings in Table 1 indicate that the right composition of knowledge-related resources can vary when the main goal of an innovation project varies. Based on the results, managers could undertake different strategies to maximize the intended outcome.

- Depending on disciplined methods help teams finish their innovation projects on time.
  - Disciplined methods formalize all the procedures and systematic steps to solve problems. Examples of disciplined methods include the Stage-Gate model, DMAIC (Define, Measure, Analyze, Improve, Control) model, DFSS (Design For Six Sigma), etc. Those methods direct team members to follow written rules to respond to emerging problems quickly.
- Make people connected and direct them with disciplined methods to save money.

    - If it is easy to directly contact other team members – via calling, email, meeting, or even informal chat in the hall – people can integrate their knowledge to solve problems effectively. Increasing the connectedness could be a better cost-saving strategy than hiring additional technical experts who work individually.
    - Disciplined methods provide systematic ways to solve problems so that team members can reach appropriate solutions with less effort and waste of money.
- Focus on social capital and relational capital resources to learn more and generate more knowledge for future business activities.
    - Knowledge is gained and integrated from face to face discussions. When team members easily contact each other without barriers in terms of time and place, discussions will be richer and occur more frequently. Many organizations co-locate people from different functional departments in the same building or room to support vibrant communication for innovation projects.
    - To generate knowledge, it is important to have a team culture in which people feel safe in taking the risk of expressing any ideas or opinions. By asking questions, seeking feedback, reporting mistakes, and proposing new ideas, team members can experience and understand different approaches to solve problems. Team leaders should encourage such these types of communications and treat other team members with respect.
    - Long-term relationships with external partners involved in an innovation project are another main source of knowledge. By committing to maintain the relationships, associated parties come to trust each other. They then share more technical information and knowledge.
- Collaboration with external partners helps project teams learn more and build appropriate capabilities for future innovation. Getting partners involved from the early steps of a project ensures a high level of discussion and knowledge sharing about materials, subsystems, technology and features of new products or processes.
- Eventually, all innovation projects aim to achieve technical goals successfully – better quality, better than competitors' products or processes, and meeting customer needs. Our

study showed that both structural capital and relational capital are important to enhance technical achievement.

- Organizations should store knowledge stocks in the forms of documents, manuals, archives, patents, or databases. The codified knowledge obtained from previous innovation projects can be effective references to understand and solve problems related to current products and processes.
- Obtain much input and expertise from external partners in every stage of your innovation project – from design to testing. Your customers help you identify what to improve, while suppliers or other third-parties help you realize how to improve. Systematic procedures to select right partners should precede the in-depth engagement with external partners.
- Including many external partners in a project ensures different views or ideas to solve current problems. A better solution is likely to be generated when a broader set of alternatives are proposed. Skills and knowledge from your partners are truly beneficial resource for your innovation.

- Our research fails to find direct impacts of human capital elements – specialists and generalists - on the performance of innovation projects, when taking account the other knowledge resources into consideration. This does not mean that human capital is not important for innovation. Rather, human capital could be an enabler. Appropriately skilled employees are necessary to build structural, social, and relational capital successfully.

Key Issue 3. Incremental projects *versus* Radical projects

Incremental projects are different from radical projects, as the latter often require much training for team members to learn new skills and procedures. Even if the target products or processes are not new to the world and have been already developed by competitors, your company might not have the competences needed to catch up immediately. In this case, you will probably need to implement radical projects to make significant changes in your current products or processes.

Our research found that intellectual capital should be carefully managed in response to the type of innovation project pursued, especially if the project focuses on cost and time performance. Since it is difficult to estimate accurate budget or due date in advance, radical innovation projects are very often delayed or exceed budgets. Our findings point to the following ways to avoid these situations.

- Radical innovation projects
  - Due to their higher level of expertise in specific task areas, specialists are able to understand new skills or knowledge better than generalists. Depending on specialists for radical innovation is a productive strategy.
  - People who work together tend to become similar. Too much interaction or direct contact of team members at the early stage of a project could block the entire team from exploring new ideas or knowledge that might help faster problem-solving.
  - Without feeling any threats of punishment or judgment by others, team members can propose and explore more approaches to learn new skills. When team members feel free to make mistakes and propose new ideas, they will generate more effective solutions to make dramatic changes in current products or processes.
  - In order to obtain new skills or learn new technology, depend on your old friends. External partners that have long term relationships with you are more willing to share critical information and knowledge.
  - When you are not familiar with your project content (as in radical projects), you have less ability to integrate and evaluate all the communications that are needed. It becomes easy to lose your pace. In these circumstances the involvement of external partners in decision making processes are likely to delay your project.
- Incremental innovation projects
  - Specialists are usually expensive labor. Instead, you could utilize disciplined methods to align project activities and obtain useful approaches to solve problems for incremental innovation.

- Project teams can expedite the overall project through direct contacts among team members to discuss and solve emerging problems that are manageable with current competences.
- Improving the features of current products or processes can usually be accomplished using well-established processes. Sacrifice team psychological safety for a high level of authority to direct project activities effectively and finish them on time.
- Maintaining long-term relationships with your external partners is not without time and cost. If you don't need new skills or knowledge to conduct innovation projects, select and work with partners purely based on your instant needs.
- When projects have low levels of uncertainty, you can design detailed processes to collaborate with external partners. They are extra resources for you to finish your projects on time.

Both incremental innovation and radical innovation are equally important to ensure the competitive advantage of an organization. Our findings suggest that incremental innovation and radical innovation require different inputs and knowledge-resources, and consequently need to be managed differently. Literature suggests that organizations should employ distinct and weakly-connected groups for the two types of innovation, thus preserving the ability to pursue different strategies, management practices, business models, and culture.

BIBLIOGRAPHY

BIBLIOGRAPHY

Abernathy, W. J., Clark, K. B. 1993. Innovation: Mapping the winds of creative destruction. Research Policy 22(2) 102-102.

Adler, P. S., Clark, K. B. 1991. Behind the learning curve: A sketch of the learning process. Management Science 37(3) 267.

Adler, P. S. 1995. Interdepartmental Interdependence and Coordination: The Case of the Design/Manufacturing Interface. Organization Science 6(2) 147-167.

Adler, P. S., Benner, M., Brunner, D. J., MacDuffie, J. P., Osono, E., Staats, B. R., Takeuchi, H., Tushman, M. L., Winter, S. G. 2009. Perspectives on the Productivity Dilemma. Journal of Operations Management 27(2) 99-113.

Ahuja, G., Lampert, C. M. 2001. Entrepreneurship in the large corporation: a longitudinal study of how established firms create breakthrough inventions. Strategic Management Journal 22(6-7) 521-543.

Alavi, M., Leidner, D. E. 2001. Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. MIS Quarterly 25(1) 107-136.

Andriessen, D. 2004. Making sense of intellectual capital : designing a method for the valuation of intangibles. Amsterdam ; Boston: Elsevier.

Argote, L., McEvily, B., Reagans, R. 2003. Managing knowledge in organizations: An integrative framework and review of emerging themes. Management Science 49(4) 571-582.

Armstrong, J. S., Overton, T. S. 1977. Estimating nonresponse bias in mail surveys. Journal of Marketing Research 14(3) 396-402.

Augier, M., Teece, D. J. 2005. An Economics Perspective on Intellectual Capital In B. Marr (Ed.), Perspectives on Intellectual Capital: 3-27. Burlington, MA: Elsevier Academic Press.

Bagozzi, R. P., Yi, Y., Phillips, L. W. 1991. Assessing construct validity in organizational research. Administrative Science Quarterly 36(3) 421-458.

Benner, M. J., Tushman, M. L. 2003. Exploitation, exploration, and process management: The productivity dilemma revisited. The Academy of Management Review 28(2) 238-256.

Berry, J. 2004. Tangible strategies for intangible assets : how to manage and measure your company's brand, patents, intellectual property, and other sources of value. New York: McGraw-Hill.

Bjurström, E., Roberts, H. 2007. The principle of connectivity: Networked assets, strategic capabilities and bundled outcomes In C. Chaminade, B. Catasâus (Eds.), Intellectual capital revisited : paradoxes in the knowledge intensive organization: xi, 194 p. Cheltenham, UK ; Northampton, MA: Edward Elgar.

Boyer, K. K., Olson, J. R., Calantone, R. J., Jackson, E. C. 2002. Print versus electronic surveys: a comparison of two data collection methodologies. Journal of Operations Management 20(4) 357-373.

Brooking, A. 1997. Intellectual capital. Boston: International Thomson Business Press.

Brown, S. L., Eisenhardt, K. M. 1995. Product Development: Past Research, Present Findings, and Future Directions. The Academy of Management Review 20(2) 343-378.

Burt, R. S. 1992. Structural holes: the social structure of competition. Cambridge, Mass.: Harvard University Press.

Cardinal, L. B. 2001. Technological Innovation in the Pharmaceutical Industry: The Use of Organizational Control in Managing Research and Development. Organization Science 12(1) 19-36.

Cezair, J. A. 2008. Intellectual Capital, Hiding in Plain View. Journal of Performance Management 21(2) 29-39.

Chen, I. J., Paulraj, A. 2004. Towards a theory of supply chain management: the constructs and measurements. Journal of Operations Management 22(2) 119-150.

Chesbrough, H. W., Vanhaverbeke, W., West, J. 2006. Open innovation : researching a new paradigm. Oxford: Oxford University Press. 24(5) 637-652

Choi, T.Y., Krause, D.R., 2006. The supply base and its complexity: Implications for transaction costs, risks, responsiveness, and innovation. Journal of Operations Management

Choo, A. S., Linderman, K. W., Schroeder, R. G. 2007. Method and psychological effects on learning behaviors and knowledge creation in quality improvement projects. Management Science 53(3) 437-450.

Cohen. 1992. A Power Primer. Psychological Bulletin 112 155-159.

Cohen, J., Cohen, P., West, S. G., Aiken, L. S. 2003. Applied multiple regression/correlation analysis for the behavioral sciences. NJ:Erlbaum: Mahwah.

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

Cook, R. D. 1979. Influential Observations in Linear Regression. Journal of the American Statistical Association 74(365) 169-174.

Cummings, J. N. 2004. Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization. Management Science 50(3) 352-364.

Daft, R. L., Becker, S. W. 1978. The innovative organization: innovation adoption in school organizations. New York: Elsevier.

Daft, R. L., Weick, K. E. 1984. Toward a model of organizations as Interpretation systems. The Academy of Management Review 9(2) 284-295.

Damanpour, F. 1991. Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators. The Academy of Management Journal 34(3) 555-590.

Danneels, E. 2002. The Dynamics of Product Innovation and Firm Competences. Strategic Management Journal 23(12) 1095-1121.

Dewar, R. D., Dutton, J. E. 1986. The Adoption of Radical and Incremental Innovations: An Empirical Analysis. Management Science 32(11) 1422-1433.

Dillman, D. A. 2000. Mail and internet surveys: The tailored design method. New York: Wiley 2nd ed.

Dougherty, D. 1992. Interpretive Barriers to Successful Product Innovation in Large Firms. Organization Science 3(2) 179-202.

Drucker, P. 1993. Post-Capitalist Society. New York: Harper Business.

Dwyer, F. R., Schurr, P. H., Oh, S. 1987. Developing Buyer-Seller Relationships. The Journal of Marketing 51(2) 11-27.

Dyer, J. H., Singh, H. 1998. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. The Academy of Management Review 23(4) 660-679.

Edmondson, A. 1999. Psychological safety and learning behavior in work teams. Administrative Science Quarterly 44(2) 350-383.

Edmondson, A. 2004. Psychological safety, trust and learning: A group-level lens. In R. M. Kramer, K. S. Cook (Eds.), Trust and distrust in organizations: dilemmas and approaches: xii, 381 p. New York: Russell Sage Foundation.

Edvinsson, L., Sullivan, P. 1996. Developing a model for managing intellectual capital. European Management Journal 14(4) 356-364.

Ehin, C. 2000. Unleashing Intellectual Capital. Boston: Butterworth-Heinemann.

Eisenberger, R., Fasolo, P., Davis-La Mastro, V. 1990. Perceived organizational support and employee diligence, commitment, and innovation. Journal of Applied Psychology 75 51-19.

Eisenhardt, K. M., Martin, J. A. 2000. Dynamic capabilities: What are they? Strategic Management Journal 21(10/11) 1105-1121.

Ettlie, J. E., Bridges, W. P., O'Keefe, R. D. 1984. Organization Strategy and Structural Differences for Radical Versus Incremental Innovation. Management Science 30(6) 682-695.

Fernström, L. 2005. A marketing Perspective on Intellectual Capital. In B. marr (Ed.), Perspectives on Intellectual Capital. Burlington, MA: Elsevier Academic Press.

Fincham, R., Roslender, R. 2003. Intellectual capital accounting as management fashion: a review and critique. European Accounting Review 12(4) 781-795.

Fiol, C. M., Lyles, M. A. 1985. Organizational Learning. The Academy of Management Review 10(4) 803-813.

Fischer, M. M. 2006. Innovation, networks, and knowledge spillovers : selected essays (1st ed.). Berlin ; New York: Springer.

Fornell, C., Larcker, D. F. 1981. Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research 18 39-51.

Freeman, C. 1991. Networks of innovators: A synthesis of research issues. Research Policy 20(5) 499-514.

Freeman, C., Soete, L. 1997. The economics of industrial innovation (3rd ed.). London ; Washington: Pinter.

Fukuyama, F. 1995. Trust : the social virtues and the creation of prosperity. New York: Free Press.

García-Meca, E., Martínez, I. 2007. The use of intellectual capital information in investment decisions: An empirical study using analyst reports. The International Journal of Accounting 42(1) 57-81.

Gatignon, H., Tushman, M. L., Smith, W., Anderson, P. 2002. A Structural Approach to Assessing Innovation: Construct Development of Innovation Locus, Type, and Characteristics. Management Science 48(9) 1103-1122.

Gersick, C. J. G., Hackman, J. R. 1990. Habitual routines in task-performing groups. Organizational Behavior Human Decision Processes 47 65-97.

Gordon, E. E. 1999. Skill Wars: Winning the Battle for Productivity and Profit Butter-worth-Heinemann.

Govindarajan, V., Kopalle, P. K. 2006. Disruptiveness of innovations: measurement and an assessment of reliability and validity. Strategic Management Journal 27(2) 189.

Granovetter, M. 1985. Economic Action and Social Structure: The Problem of Embeddedness. The American Journal of Sociology 91(3) 481-510.

Granovetter, M. S. 1973. The Strength of Weak Ties. The American Journal of Sociology 78(6) 1360-1380.

Griffin, A., R.Hauser, J. 1996. Integrating R&D and Marketing: A Review and Analysis of the Literature. The Journal of Product Innovation Management 13(3) 191-215.

Griffith, T. L., Sawyer, J. E., Neale, M. A. 2003. Virtualness and Knowledge in Teams: Managing the Love Triangle of Organizations, Individuals, and Information Technology. MIS Quarterly 27(2) 265-287.

Grindley, P. C., Teece, D. J. 1997. Managing intellectual capital: Licensing and cross-licensing in semiconductors and electronics. California Management Review 39(2) 8-41.

Gupta, A. K., Govindarajan, V. 2000. Knowledge flows within multinational corporations. Strategic Management Journal 21(4) 473.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., Tatham, R. L. 2005. Multivariate data analysis (6th ed.): Prentice Hall.

Hall, R. 1993. A Framework Linking Intangible Resources and Capabilities to Sustainable Competitive Advantage. Strategic Management Journal 14(8) 607-618.

Hansen, M. T. 1999. The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge across Organization Subunits. Administrative Science Quarterly 44(1) 82-111.

Hansen, M. T., Podolny, J. M., Pfeffer, J. 2001. So many ties, so little time: A task contingency perspective on corporate social capital in organizations. Research in the Sociology of Organizations 18 21-57.

Hayes, R., Pisano, G., Upton, D., Wheelwright, S. 2005. Operations, Strategy, and Technology: Pursuing the competitive edge: John Wiley & Sons, Inc.

He, Z. L., Wong, P. K. 2004. Exploration vs. Exploitation: An Empirical Test of the Ambidexterity Hypothesis. Organization Science 15(4) 481-494.

Henderson, R. 1993. Underinvestment and Incompetence as Responses to Radical Innovation: Evidence from the Photolithographic Alignment Equipment Industry. The Rand Journal of Economics 24(2) 248-270.

Henderson, R. 1994. Managing Innovation in the Information Age. Harvard Business Review 72(1) 100-107.

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

Hudson. 1993. Intellectual Capital: How to build It, Enhance It, Use It. New York: Wiley.

Iansiti, M. 2000. How the incumbent can win: Managing technological transitions in the semiconductor industry. Management Science 46(2) 169-185.

Im, G., Rai, A. 2008. Knowledge Sharing Ambidexterity in Long-Term Interorganizational Relationships. Management Science 54(7) 1281-1296.

Jansen, J. J. P., Bosch, F. A. J. V. D., Volberda, H. W. 2006. Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. Management Science 52(11) 1661.

Jaworski, B. J., Kohli, A. K. 1993. Market Orientation: Antecedents and Consequences. The Journal of Marketing 57(3) 53-70.

Jehn, K. A., Northcraft, G. B., Neale, M. A. 1999. Why differences make a difference: A field study of diversity, conflict, and performance in workgroups. Administrative Science Quarterly 44(4) 741.

Johnson, H. T., Kaplan, R. S. 1987. Relevance lost : the rise and fall of management accounting. Boston, Mass.: Harvard Business School Press.

Kang, S. C., Morris, S. S., Snell, S. A. 2007. Relational archetypes, organizational learning, and value creation: Extending the human resource architecture. Academy of Management Review 32(1) 236-256.

Kang, S. C., Snell, S. A. 2009. Intellectual Capital Architectures and Ambidextrous Learning: A Framework for Human Resource Management. Journal of Management Studies 46(1) 65-92.

Kaplan, R. S., Norton, D. P. 2001. The strategy-focused organization : how balanced scorecard companies thrive in the new business environment. Boston, Mass.: Harvard Business School Press.

Katila, R. 2002. New Product Search over Time: Past Ideas in Their Prime? The Academy of Management Journal 45(5) 995-1010.

Katila, R., Ahuja, G. 2002. Something Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction. The Academy of Management Journal 45(6) 1183-1194.

Kearney, E., Gebert, D., Voelpel, S. C. 2009. When and how diversity benefits teams: The importance of team members' need for cognition Academy of Management Journal 52(3) 581-598.

Kimberly, J. R., Evanisko, M. J. 1981. Organizational Innovation: The Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and

Administrative Innovations. The Academy of Management Journal 24(4) 689-713.

Kirmeyer, S. L. 1988. Coping with competing demands: Interruption and the type A pattern. . Journal of Applied Psychology 73(4) 621-629.

Knott, A. M. 2008. R&D/Returns Causality: Absorptive Capacity or Organizational IQ. Management science 54(12) 2054-2067.

Koufteros, X. A., Edwin Cheng, T. C., Lai, K. H. 2007. "Black-box" and "gray-box" supplier integration in product development: Antecedents, consequences and the moderating role of firm size. Journal of Operations Management 25(4) 847-870.

Krause, D. R., Handfield, R. B., Tyler, B. B. 2007. The relationships between supplier development, commitment, social capital accumulation and performance improvement. Journal of Operations Management 25(2) 528-545.

Kutner, M. H., Nachtsheim, C. J., Neter, J. 2004. Applied Linear Regression Models (fourth ed.). New York: McGraw-Hill/Irwin.

Lane, P., Salk, J. E., Lyles, M. A. 2001. Absorptive capacity, learning, and performance in international joint ventures. Strategic Management Journal 22(12) 1139-1161.

Lane, P. J., Lubatkin, M. 1998. Relative absorptive capacity and interorganizational learning. Strategic Management Journal 19(5) 461.

Lane, P. J., Koka, B. R., Pathak, S. 2006. The reification of absorptive capacity: A critical review and rejuvenation of the construct The Academy of Management Review 31(4) 833-863.

Lechner, C., Frankenberger, K., Floyd, S. W. 2010. Task contingencies in the curvilinear relationships between intergroup networks and initiative performance. Academy of Management Journal 53(4) 865-889.

Lev, B. 2001. Intangibles: Management, Measurement, and Reporting. Washington, DC: The Brookings Institution.

Levin, D. Z., Cross, R. 2004. The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. Management Science 50(11) 1477-1490

Levinthal, D., March, J. G. 1981. A model of adaptive organizational search Journal of Economic Nehavior and Organization 2 307-333.

Levinthal, D., Rerup, C. 2006. Crossing an Apparent Chasm: Bridging Mindful and Less-Mindful Perspectives on Organizational Learning. Organization science 17(4) 502-513.

Lindell, M. K., Whitney, D. J. 2001. Accounting for Common Method Variance in Cross-Sectional Research Designs. Journal of Applied Psychology 86(1) 114-121.

Louca, F., Mendonca, S. 2002. Steady change: the 200 largest US manufacturing firms throughout the 20th century. Ind Corp Change 11(4) 817-845.

Lyles, M. A., Mitroff, I. I. 1980. Organizational Problem Formulation: An Empirical Study. Administrative Science Quarterly 25(1) 102-119.

MacDuffie, J. P. 1997. The road to "root cause": Shop-floor problem-solving at three auto assembly plants. Management Science 43(4) 479-502.

Madhavan, R., Grover, R. 1998. From embedded knowledge to embodied knowledge: New product development as knowledge management. Journal of Marketing 62 1-12.

Malhotra, A., Gosain, S., Sawy, O. A. E. 2005. Absorptive capacity configurations in supply chains: Gearing for partner-enabled market knowledge creation. MIS Quarterly 29(1) 145-187.

Mallick, D. N., Schroeder, R. G. 2005. An Integrated Framework for Measuring Product Development Performance in High Technology Industries. Production and Operations Management 14(2) 142-158.

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

Marr, B. (Ed.). 2005. Perspectives on intellectual capital. Burlington, MA: Elsevier Academic Press.

McFadyen, M. A., Cannella Jr, A. A. 2004. Social capital and knowledge creation: diminishing returns of the number and strength of exchange relationships. Academy of Management Journal 47(5) 735-746.

Menor, L. J., Kristal, M. M., Rosenzweig, E. D. 2007. Examining the influence of operational intellectual capital on capabilities and performance. Manufacturing & Service Operations Management 9(4) 559-578.

Miles, R. E., Miles, G., Snow, C. C., Blomqvist, K., Rocha, H. 2009. The I-Form Organization. California Management Review 51(4) 59.

Molnar, M. J. 2004. Executive veiws on Intangible Assets, Insights From the Accenture/Economist Intelligence unit Survey.

Moore, G. C., Benbasat, I. 1991. Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. Information Systems Research 2(3) 192-222.

Morgan, R. M., Shelby, D. H. 1994. The Commitment-Trust Theory of Relationship Marketing. The Journal of Marketing 58(3) 20-38.

Moss, S., Prosser, H., Costello, H., Simpson, N., Patel, P., Rowe, S., Turner, S., Hatton, C. 1998. Reliability and validity of the PAS-ADD Checklist for detecting psychiatric disorders in adults with intellectual disability. Journal of Intellectual Disability Research 42(2) 173-183.

Nahapiet, J., Ghoshal, S. 1998. Social capital, intellectual capital, and the organizational advantage. The Academy of Management Review 23(2) 242-266.

Nahm, A. Y., Vonderembse, M. A., Koufteros, X. A. 2003. The impact of organizational structure on time-based manufacturing and plant performance. Journal of Operations Management 21(3) 281-306.

Nambisan, S. 2003. Information Systems as a Reference Discipline for New Product Development. MIS Quarterly 27(1) 1-18.

Narayanan, S., Balasubramanian, S., Swaminathan, J. M. 2009. A Matter of Balance: Specialization, Task Variety, and Individual Learning in a Software Maintenance Environment. Management science .

Naveh, E., Erez, M. 2004. Innovation and Attention to Detail in the Quality Improvement Paradigm. Management Science 50(11) 1576-1586.

Nelson, R. R., Winter, S. G. 1982. An evolutionary theory of economic change. Cambridge, Mass.: Belknap Press of Harvard University Press.

Nonaka, I. 1991. The knowledge-creating company. Harvard Business Review 69(6) 96-104.

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

Nunnally, J. C. 1978. Psychometric theory (2d ed.). New York: McGraw-Hill.

Pelled, L. H., Eisenhardt, K. M., Xin, K. R. 1999. Exploring the Black Box: An Analysis of Work Group Diversity, Conflict, and Performance. Administrative Science Quarterly 44(1) 1-28.

Perlow, L. A. 1999. The Time Famine: Toward a Sociology of Work Time. Administrative Science Quarterly 44(1) 57-81.

Petersen, K. J., Handfield, R. B., Ragatz, G. L. 2005. Supplier integration into new product development: coordinating product, process and supply chain design. Journal of Operations Management 23(3-4) 371-388.

Podasakoff, P. M., MacKenzie, S. B., Lee, J.-Y., Podsakoff, N. P. 2003. Common method biases in behavioral research: A critical review of the literature and recommended remedies. Journal of Applied Psychology 88(5) 879-903.

Primo, M. A. M., Amundson, S. D. 2002. An exploratory study of the effects of supplier relationships on new product development outcomes. Journal of Operations Management 20(1) 33-52.

Putnam, R. D. 1995. Bowling alone: America's declining social capital. Journal of Democracy 6(1) 65-78.

Rajesh, K. C., Gerard, J. T. 1998. Organizing for radical product innovation: The over-looked role of willingness to cannibalize. Journal of Marketing Research 35(4) 474.

Richardson, J. G. 1986. Handbook of theory and research for the sociology of education. New York: Greenwood Press.

Rogelberg, S. G., Stanton, J. M. 2007. Introduction: Understanding and dealing with organizational survey nonresponse. Organizational Research Methods 10(2) 195-209.

Roos, J. 1998. Exploring the concept of intellectual capital (IC). Long Range Planning 31(1) 150-153.

Rosenkopf, L., Nerkar, A. 2001. Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disk Industry. Strategic Management Journal 22(4) 287-306.

Roth, A. V., Marucheck, A. S., Kemp, A., Trimble, D. 1994. The knowledge factory for accelerated learning practices. Planning Review 22(3) 26-32.

Rothaermel, F. T., Hess, A. M. 2007. Building Dynamic Capabilities: Innovation Driven by Individual-, Firm-, and Network-Level Effects. Organization science 18(6) 898-921.

Rowley, T., Behrens, D., Krackhardt, D. 2000. Redundant governance structures: an analysis of structural and relational embeddedness in the steel and semiconductor industries. Strategic Management Journal 21(3) 369-386.

Ruekert, R. W., Walker, O. C. 1987. Marketing's interaction with other functional units: A conceptual framework and empirical evidence. Journal of Marketing 51 1-19.

Schankerman, M. 1998. How Valuable is Patent Protection? Estimates by Technology Field. The RAND Journal of Economics 29(1) 77-107.

Schilling, M. A., Phelps, C. C. 2007. Interfirm Collaboration Networks: The Impact of Large-Scale Network Structure on Firm Innovation. Management science 53(7) 1113-1126.

Schultz, T. W. 1961. Investment in Human Capital. The American Economic Review 51(1) 1-17.

Schultze, U., Leidner, D. E. 2002. Studying Knowledge Management in Information Systems Research: Discourses and Theoretical Assumptions. MIS Quarterly 26(3) 213-242.

Siemsen, E., Roth, A. V., Balasubramanian, S., Anand, G. 2008. The Influence of Psychological Safety and Confidence in Knowledge on Employee Knowledge Sharing. Manufacturing service operations management.

Sinkula, J. M. 1994. Market information processing and organizational learning. Journal of Marketing 58(1) 35-45.

Slater, S. F., Narver, J. C. 1995. Market orientation and the learning organization. Journal of Marketing 59(3) 63-74.

Song, M., Di Benedetto, C. A. 2008. Supplier's involvement and success of radical new product development in new ventures. Journal of Operations Management 26(1) 1-22.

Srivastava, R. K., Fahey, L., Christensen, H. K. 2001. The resource-based view and marketing: The role of market-based assets in gaining competitive advantage. Journal of Management 27(6) 777-802.

Stein, E. W., Zwass, V. 1995. Actualizing Organizational Memory with Information Systems. Information systems research 6(2) 85-117.

Stewart, T. A. 1997. Intellectual capital : the new wealth of organizations (1st ed.). New York: Currency.

Stratman, J. K., Roth, A. V. 2002. Enterprise Resource Planning (ERP) Competence Constructs: Two-Stage Multi-Item Scale Development and Validation. Decision Sciences 33(4) 601-628.

Subramaniam, M., Youndt, M. A. 2005. The influence of intellectual capital on the types of innovative capabilities Academy of Management Journal 48(3) 450-463.

Swink, M. 1999. Threats to new product manufacturability and the effects of development team integration processes. Journal of Operations Management 17(6) 691-709.

Swink, M. 2002. Product development--faster, on-time. Research Technology Management 45(4) 50.

Swink, M., Talluri, S., Pandejpong, T. 2006. Faster, better, cheaper: A study of NPD project efficiency and performance tradeoffs. Journal of Operations Management 24(5) 542-562.

Szulanski, G. 1996. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. Strategic Management Journal 17 27-44.

Taylor, A., Greve, H. R. 2006. Superman or the fantastic four? Knowledge combination and experience in innovative teams. Academy of Management Journal 49(4) 723-740.

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

Teece, D. J. 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strategic Management Journal 28(13) 1319-1350.

Tellis, G. J., Prabhu, J. C., Chandy, R. K. 2009. Radical Innovation Across Nations: The Preeminence of Corporate Culture. Journal of Marketing 73(1) 3-23.

Tsai, K. H. 2009. Collaborative networks and product innovation performance: Toward a contingency perspective. Research Policy 38(5) 765-778.

Tsai, W. 2001. Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. Academy of Management Journal 44(5) 996-1004.

Tu, Q., Vonderembse, M. A., Ragu-Nathan, T. S., Sharkey, T. W. 2006. Absorptive capacity: Enhancing the assimilation of time-based manufacturing practices. Journal of Operations Management 24(5) 692-710.

Tushman, M. L., Anderson, P. 1986. Technological Discontinuities and Organizational Environments. Administrative Science Quarterly 31(3) 439-465.

Verona, G., Ravasi, D. 2003. Unbundling dynamic capabilities: an exploratory study of continuous product innovation. Ind Corp Change 12(3) 577-606.

Weick, K. E. 1979. The Social Psychology of Organizing. MA: Addison Wesley Publishing Company, Reading.

Zack, M. H. 1999. Developing a knowledge strategy. California Management Review 41(3) 125.

Zahra, S. A., George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. The Academy of Management Review 27(2) 185-203.

Zellmer-Bruhn, M. E. 2003. Interruptive Events and Team Knowledge Acquisition. Management science 49(4) 514-528.

Zucker, L. G., Darby, M. R., Brewer, M. B. 1998. Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises. The American Economic Review 88(1) 290-306.