AN INVESTIGATION OF THE EFFECTS OF IT INVESTMENT ON FIRM PERFORMANCE: THE ROLE OF COMPLEMENTARITY

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AN INVESTIGATION OF THE EFFECTS OF IT INVESTMENT ON FIRM PERFORMANCE: THE ROLE OF COMPLEMENTARITY

A Dissertation APPROVED FOR THE

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(Division of Management Information Systems)

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ABSTRACT

The concept of complementarity has been introduced into IT-based firm performance research in order to address inconsistent magnitudes of the impacts from IT investments across studies. This dissertation seeks to understand the scope of IT investment complementarities, to examine the different ways in which different complementarities impact the payoff from an IT investment, and to empirically test the effects of complementary investments in the context of investments in SCM and CRM. The knowledge-based view of the firm (KBV) is employed in order to understand a boundary and different roles of complementarity. The KBV sees organizational capabilities from the *aggregation of knowledge into capabilities* and *the deployment of knowledge assets in the form of capabilities*. Knowledge aggregation requires individuals' specialized knowledge (*human capital*) and the aggregation mechanisms of *structural, social, and community capital*. The combination of these three forms of capital, together with human capital, constitutes organizational capabilities.
Once constituted, the complementary deployment of capabilities is important. *Foundational capability* must be in place in order for the focal IT investment to deliver value, *synergistic capability* amplifies the economic benefits of the focal IT investment, and *management capability* is managers' organizing vision and capability to successfully deploy the focal IT investment.

The data for this study were drawn from secondary data sources: Annual Reports, Press Releases, and news articles. The dependent variables are drawn from COMPUSTAT. The data collection method for the independent variables was a

keyword search. The research sampling frame is confined within a single value chain however distinctively different industry categories are represented within this value chain. This sampling strategy yielded a total of 111 firms that had invested in SCM and 45 firms that had invested in CRM.

The research findings show that three forms of structural, community, and human capital have highly significant impacts on firm performance measured by Net Cash Flow, Gross Profit, and EBITDA. Synergistic capabilities and management capabilities are found to be highly significant in moderating between three forms of capital and firm performance measurements.

CHAPTER I: INTRODUCTION

Information technology (IT) investments have continued to increase over the last few decades (Kobelsky et al., 2002) while, concurrently, executives continue to question the value being obtained from these investments (Lederer and Mendelow, 1997). Although there are some contradictory research findings (e.g., Weill, 1992), in general some constructs have found to be significant to firm performance, e.g., industry effects (Im et al., 2001), top management team's support (Weill, 1992), and IT capability (Bharadwaj et al., 1999). However, findings concerning the magnitude of IT investment impacts have been inconsistent.

In order to address this issue, scholars have recently introduced the concept of complementarity in order to better understand the manner in which IT investments impact firm performance (Barua and Mukhopadhyay, 2000). However, this concept has been insufficiently developed in the literature and has inherent limitations in its perspective. The purpose of this study is to further develop and clarify our understanding of complementarity and apply this elaborated concept to IT productivity research. This section includes a review of the problems with existing IT productivity studies, an overview of this study and its research question, and a summary of the dissertation's organization.

1.1. Research on IT Productivity

Although previous scholars have significantly advanced our understanding of the impact of IT investments on firm productivity, the field still has some inherent problems These problems are largely due to difficulties in modeling the IT investment/ productivity

relationship, the use of different measurement metrics and definitions of IT investments, and to variances in the extent to which complementary investments are considered.

The first problem relates to the modeling of the IT investment / firm performance relationship. While scholars have attempted to measure the direct relationship between IT investments and firm performance (e.g., Weill, 1992; Bharadwaj et al., 1999), they have often not accounted for the effects of numerous intervening variables and time lags (Kelly, 1994) between IT investments and firm performance (Devaraj and Kohli, 2003; Brynjolfsson and Hitt, 1996; Dewan and Min, 1997; Lee and Barua, 1999). These intervening variables and lag effects obscure the true impacts of IT investments and result in conflicting findings across studies (e.g., Kohli and Devaraj, 2003; Bresnahan, 1986). Focusing on investments in specific IT applications rather than the totality of organizational investments in IT makes it easier to observe the direct relationships between IT investments and performance, and research findings at this level are relatively consistent (Lee, Clark, and Tam, 1999; Mukhopadhyay et al., 1997; Kekre, and Mukhopadhyay et., Srinivasan et al., 1994).

The second problem within the body of IT/ productivity research is that the metrics used to measure IT investments vary widely across studies. Often the measurement metrics are loosely related to input variables. For example, the economic value of mainframe investments are measured by firm profits (Bresnahan, 1986), and IT expenditures from *Computerworld* are used for cost efficiency (Mitra and Chaya, 1996) and productivity measurements (Dewan and Min, 1997). Further, the term, IT investments, is loosely defined, e.g., mainframe investments (Bresnahan, 1986), a ratio of IT deployment (Aplar and Kim, 1990), IT expenditure (Brynjolfsson, 1993), or

announced IT investments (Dos Santos et al., 1993). The consequent mismatch between assessments of investments and assessments of their impacts may contribute to the inconsistencies in findings. Here too application-level studies tend to assess outcomes that are specific to the IT investments being considered, and therefore, the IT impacts noted are relatively consistent.

In addition to the lack of proximity and commensurateness between investments studied and performance metrics employed, disparities in research findings are attributable to the extent to which complementary investments are considered (Barua and Mukhopadhyay, 2000). This study therefore uses two strategies to better explain the effects of IT investments on productivity. First, it focuses on application-level IT investments, specifically, supply chain management (SCM) and customer relationship management (CRM), which have the potential to directly and significantly impact specific firm performance variables as summarized in Table 1-1. Second, this research focuses on performance metrics that are *proximate to* and *commensurate with* the investments deployed. This is expected to (1) minimize the confounding effects of unaccounted for intervening variables and (2) militate against a Type II error through appropriate assessment of the dependent variable.

Table 1-1: Impacts of CRM and SCM on Firm Performance

Applications	Authors	Profitability
CRM	IOMA (2003)	♦ 182% of ROE, 23% of cost reduction, and 434% of ROI increase in the top-five global financial institution ♦ 94% of ROE, 51%of productivity, and 106% ROI increases, and 18% cost reduction in a pharmaceutical company ♦ 115% of ROE and 78% ROE in a medical supplier manufacturer
	Dyche (2002)	♦ 400 % increase in ROI in FEDEX

Applications	Authors	Profitability
SCM	Worthen (2002)	♦ Best vs. median o 35 vs. 74 days for inventory o 36 vs. 84 days for cash-to-cash cycle o 9 vs. 20 days for response time for a 20% rise in demand
	Cook and Hagey (2003)	♦ SCM costs are o 9.8% for average firms of revenue o 4.2% for efficient firms of revenue ♦ Inventory in 2001 o 4.2 days for efficient firms o 24.1 days for average firms

Third, this research considers investment complementarities based on the premise that a focal IT investment cannot increase firm productivity alone. In fact, the failure of applications implementations has not been attributed to technical reasons, but rather to the retention of existing business processes that are incompatible with the new applications (IOMA, 2003). Here, investment complementarities entail prior or concurrent investments in ancillary business and technological assets and changes in existing technological and business processes. While the conventional sense of complementarity in this literature considered the payoffs from *pairs* of inputs, Milgrom and Roberts (1990, p. 514) expanded this conceptualization of "complements" in referencing a *relation among groups of activities*. The defining characteristic of these groups of complements is that if the levels of any subset of the activities are increased, then the marginal return to increases in any or all of the remaining activities rises. It then follows that if the marginal costs associated with some activities fall, it will be optimal to increase the level of all of the activities in the grouping." Hence, the concept of complementarity is defined here as *a set of mutually-reinforcing investments*. These investments are interdependent and reciprocal in nature.

1.2. Overview of Study Context

As noted earlier, the context for this study is firms' investments in SCM and CRM applications. Before we explore the issue of complementarity with regard to SCM and CRM, it is informative to examine the nature of these applications. To begin with, the benefits that accrue from each of these investment domains are summarized in Table 1-2.

Table 1-2: Examples of the Roles of Two Capabilities

CRM	SCM
♦ Identify potential new customers ♦ Determining the needs of existing and potential new customers ♦ Learning about product usage and application ♦ Developing/executing advertising program ♦ Developing/executing promotion programs ♦ Developing/executing service programs ♦ Acquiring/leveraging information technology/system for customer contact ♦ Managing customer site visit teams ♦ Enhancing trust and customer loyalty ♦ Cross-selling and upselling of product service offerings	♦ Selecting and qualifying desired suppliers ♦ Establishing and managing inbound logistics ♦ Designing and managing internal logistics ♦ Establishing and managing outbound logistics ♦ Designing work flow in product/solution assembly ♦ Running batch manufacturing ♦ Acquiring, installing, and maintaining process technology ♦ Order processing, pricing, billing, rebates, and terms ♦ Managing channels ♦ Managing customer services such as installation and maintenance to enable product use

Adopted from Srivastava, Shervani, and Fahey (1999, p. 170)

The issue of complementarity is especially salient in the adoption of SCM and CRM capabilities. Although the individual capability of each investment has the potential to increase profitability, treating the two investments as complementary are likely to bring higher levels of performance as each has an inherent potential to amplify the effects of the other. For example, when a CRM application identifies potential new customers who want specific products, the SCM application can quickly identify the required input materials and qualifying providers. Through this efficient information

flow, the firm can reduce time to market and deliver the products that customers want which will result in an increase in the firm's cash-flow. These complementary benefits are shown in Table 1-3.

Table 1-3: Examples of Benefits of CRM-SCM Complementarity

CRM-SCM complementarity benefits
♦ Accelerating cash flows
♦ Enhancing cash flows
♦ Maximize customer value by providing products quickly
♦ Reduced costs and faster time to market
♦ Lower product launch costs; lower sales and service costs
♦ Use market information and forecasts to reduce costs and inventories and enhance capacity use for higher-value products (e.g., dynamic pricing/yield management)
♦ Speed up adoption by channels and customer satisfaction
♦ Reduce order delivery cycle time

Sources: Dyche (2002); Srivastava, Shervani, and Fahey (1999)

Table 1-3 shows the effects of complementarity from the investments in CRM and SCM. While these IT capabilities offer different individual benefits, their complementary effects are high. The next section introduces this study's research questions.

1.3. Research Questions

The main research question of this dissertation is *what is the effect of complementary investments in the relationship between IT investments and firm performance?* In answering this question, this study aims to provide new insights into the relationship between IT investments and firm performance.

1.4. Organization of Dissertation

The ensuing dissertation chapters are organized as follows. Chapter 2 reviews previous literature on IT performance. From this literature review, salient variables that explain variance in firm performance are identified. These are IT investments, complement of IT investment, industry effects, and enterprise-level IT management. A

detailed discussion of previous studies of complementarity is also provided. The focus of this chapter, therefore, is to identify current state of IT productivity literature, identify gaps, and fill these gaps.

Chapter 3 develops the theoretical foundation for this research. Complementarity theory was initially developed in the economics discipline and has been applied to IT productivity research. Although scholars have expanded the theory through the addition of new constructs and operationalizations, a systematic effort to integrate these new constructs and revise the overarching theory has yet to be made. Therefore, this chapter focuses on developing an overarching theory of complementarity through the Knowledge-Based View (KBV) of the firm. Through this theoretical lens, this chapter also explicates investment-specific and investment-related capabilities and identifies different roles of these capabilities. Investment-specific capabilities are those complementary investments that are directly aimed at value extraction from a focal investment. Investment-related capabilities are those investments that may be invested for other organizational purposes, but, when present, enable and amplify the value of the focal investment.

Chapter 4 develops the research model and hypotheses based on the discussions of complementarities in Chapter 3. The hypotheses on the different roles complementarities are based on previous literature and the KBV.

Chapter 5 provides detailed information on the operationalizations of the complementarity constructs. The operationalizations of the constructs are based on previous studies on SCM and CRM. Also, examples are provided when a measurement selection is made.

Chapter 6 discusses the research methods. It provides information on how the research sample is selected, the specific data sources for the independent and dependent variables and the search words used for data collection. Additionally, this chapter explains the assignment of coding values and the method by which the data are analyzed to answer the research question.

Chapter 7 reports the results of factor analysis and hierarchical regression analyses. Factor analysis is employed in order to examine whether the selected measurement items that attempt to measure theoretically identified constructs are factored according to respective constructs. Hierarchical regression analysis is used in order to explore the extent to which the complementarity constructs explain the firm performance measurement in addition to the control variable. Also, detailed discussions of research findings of SCM and CRM analyses are offered.

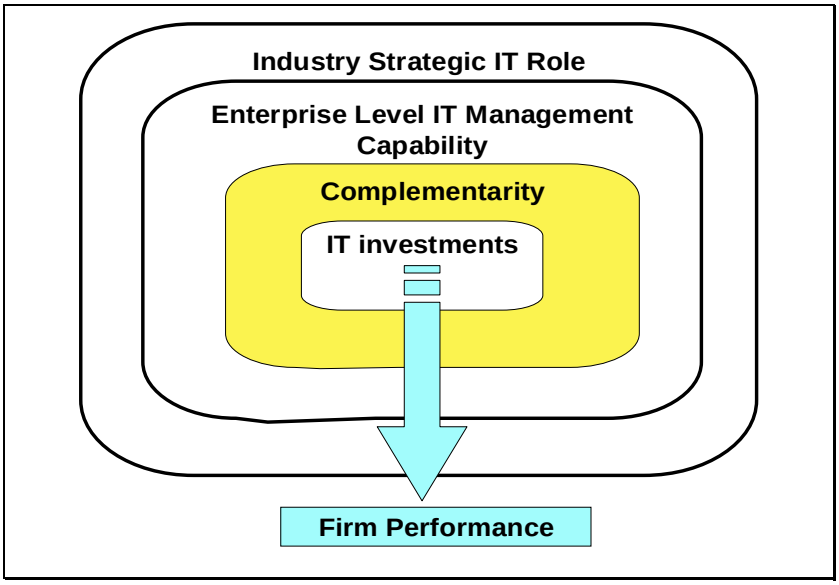
Chapter 8 concludes the dissertation by examining whether the research question is answered and by identifying emerging patterns of SCM and CRM analyses. This chapter also discusses the study's limitations and suggests directions for future research regarding the role of complementary investments in the IT investment / firm performance relationship.

CHAPTER II: LITERATURE REVIEW

A number of studies have explored the impacts of IT investments on firm performance. Figure 2.1 provides a conceptual model that organizes these contributions of previous research. The ensuing literature review is organized around this model. Scholars have found the industry strategic IT role and enterprise IT management to be important factors in explaining firm performance. Enterprise IT management includes top management commitment to IT, IT management capability, and strategic alignment between technology and business strategies. This study proposes that these constructs impact levels of both IT investment and complementary investments. These complementary investments then moderate the relationships between IT investment and firm performance.

This section begins with a discussion of IT investments and then explores the constructs of complementarity, enterprise IT management, and industry strategic IT role. The literature on IT investment studies provides the bases for the other constructs and allows one to understand the current state of IT productivity research. This is the next section that introduces the concept of complementarity as a moderating construct that has not been fully understood in the area of the IT productivity study. Next, the construct of enterprise IT management will be discussed. Lastly, how different industries exploit the capabilities of IT opportunities is discussed.

Figure 2.1: The Conceptual Model



2.1. IT Investments and Firm Performance

The scope of this literature review is limited to those studies that explore the relationship between IT investments and firm performance. The discussion of this section is organized based on Markus and Robey's (1988) differentiation of technological and organizational imperatives, and subsequently by level of analysis. The technological imperative perspective views technology as the main driver of firm performance. In contrast, organizational imperative scholars see managers as enablers who act purposefully choose technology in order to accomplish intended objectives (Markus and Robey, 1988). We begin with national-level studies from a technology imperative perspective (see Table 2.1).

2.1.1. Technological Imperative: National-level Studies

Table 2.1: National Level and Technology Imperative Studies

Authors	Independent variables	Dependent variables	Results	Comments
Tam (1988)	IT investment from Asia Computer Directory.	1. ROA 2. ROE 3. ROS 4. Shareholder's return	1. IT investment is not correlated with shareholder's return. 2. Other measures are mixed	Newly developed countries (Hong Kong, Singapore, Malaysia, and Taiwan)
Dewan and Kraemer (2000)	IT investments	GDP outputs.	Developed countries show a significant productivity effect with IT capital investments but not with non-IT capital investments. Developing countries show a significant relationship with non-IT capital investments, but not with IT capital investment.	36 countries (developed and developing) over the 1985-1993 period

Two studies have measured the impacts of IT investments at a national level. The first study of five newly developed countries doesn't depict a strong relationship between IT investment and shareholders' return across the countries in the sample (Tam, 1998). The second study may partially shed light on this finding (Dewan and Kraemer, 2000). Investments in IT-capital are positively related to GDP outputs in the developed countries, while non-IT capital is highly related to GDP in the developing countries. This finding may be partially attributed to the industrial structure and, consequently, the differential firm IT-related capabilities of countries, which allows them to exploit IT opportunities (Chatterjee, et al., 2001). However, this level of study does not permit researchers to examine factors that discriminate across firms' performance. As the research setting is larger, an increasing number of variables obscure the relationship between IT investments and performance, making it difficult to address specific constructs that truly impact IT performance.

2.1.2. Technology Imperative: Industry Level

Table 2.2: Environmental Imperative Study

Authors	Independent variables	Dependent variables	Results
Krishnan and Sriram (2000)	Y2K compliance expenditure.	The SEC required firms to make a Y2K related disclosure.	Market value of the firm is positively related to Y2K expenditures, but the coefficient is less than for earnings or book value, and less in IT-intensive industries.

One environmental level study has been identified in Table 2.2. Krishnan and Sriram (2000) explore the relationship between Y2K expenditure and market values of the firm. This level of study also makes it difficult to extract important constructs that determine IT performance. However, it appears that firms that align their strategy with environmental changes seem to perform better although the relationship is weak. It could be that the IT-intensive industries have already made investments for Y2K, and accordingly these expenditures may not be a major driving force for firm performance.

2.1.3. Technology Imperative: Firm Level

Table 2.3: Firm Level and Technology Imperative Studies

Authors	Independent variables	Dependent variables	Results	Comments
Harris and Katz (1991)	IT investment	1. Operating cost efficiency ratio (IT expense ratio). 2. IT cost efficiency ratio (premium income)	1. Operating cost efficiency ratio (IT expense ratio) is higher in the top performance firms. 2. IT cost efficiency ratio (premium income) is lower in top performance firms.	40 out of the top 100 insurance companies, 1983-1986. Economies of scale Large firms enjoyed high performance from IT expenditure – scale of economy.
Mitra and Chaya (1996)	IT budget as percentage of sales, averaged over period of time. Sources: *Computerworld* (1988 to 1992).	1. Operating costs 2. Production costs 3. Overhead costs 4. Firm size	1. Lower average production costs 2. Lower average total costs 3. Higher average overhead costs. 4. Large firms allocate higher levels of IT budget.	400 medium-sized to large U.S. companies
Dewan and Min (1997)	IT capital.	Production of goods and services	IT contributes significantly to various measures of	Large corporations – mainly *Fortune* 500 manufacturing

Authors	Independent variables	Dependent variables	Results	Comments
			productivity and cost efficiency. It is clear that IT substitutes for ordinary capital and labor over time.	and service firms. Data are from IDG/ C*omputerworld* between 1988 and 1992.
Bresnahan (1986)	Main frame	Firm profits Consumer surplus	Consumer surplus was five to six times larger than IT investments in the financial services sectors.	Industry effects. This output is not captured by manufacturers of computers.
Brynjolfsson and Hitt (1996)	IT stock. IT spending from International Data Group (IDG)	1. Gross rate of return 2. Marginal products	1. Positive relationship with marginal products 2. Marginal products vary across time 3. Marginal products vary with industries	367 firms from *Fortune 500* manufacturing and service firms. Firm level. IDG data collected in 1987 to 1991.
Hitt and Brynjolfsson (1996)	IT stock. IT spending from International Data Group (IDG)	1. Productivity 2. Business profitability 3. Consumer surplus	1. Productivity 2. Consumer surplus	370 large *Fortune 500* manufacturing and service sectors from Fortune 500
Brynjolfsson (1993)	IT expenditure	Productivity 1. Mismeasurement 2. Time lag due to learning effect 3. Redistribution between well-, and poorly-performing firms 4. Mismanagement – ability to leverage IT for the firm		1. Manufacturing and service sectors. 2. Complementarity investment such as employee training should be considered.
Sircar, Turnbow, and Bordoloi (2000)	IT investments: MIS budget, processor value (hardware current market value), IT staff ratio, IT training ratio, and number of PC and terminals.	1. Sales 2. Net income before tax 3. Market share 4. Assets 5. Equity	Numerous significant correlations between IT measures and firm performance measures.	Data from IDC (International Data Corporation) collected in 1988 to 93.
Bharadwaj, Bharadwj, and Konsynski (1999)	IT spending that represents the corporate capital and operating budget for IT and services.	Tobin's *q*.	IT investment and Tobin's *q* are positively related. Industry capital intensity and number of employees are negatively related to Tobin's *q*. Regulation has both	*InformationWeek* – 500.

Authors	Independent variables	Dependent variables	Results	Comments
			signs. Market share, advertising are positively related to Tobin's *q*.	
Im, Dow, and Grover (2001)	Announcements of IT investments.	Abnormal stock market return	The market value of the firm and the full sample are not correlated. Industry effect exists. IT investment announcement in financial firms has a greater effect on firm performance than manufacturing firms. Small firms' announcement on IT investment has a greater effect on firm performance than large firms'. Time lag exists.	238 publicly trading firms whose data on firm size are available in COMPUSTAT.
Dos Santos, Peffers, and Mauer (1993)	Announcement of IT investments – event study.	Total shareholder return.	The announcement of innovative IT investment and stock prices is highly related while non-innovative and unclassified investments are not.	
Dehning, Richardson, and Zmud (2003)	Announcement of IT investment	Cumulated abnormal return – stock prices	1. Industry effects 2. Higher returns with investments in strategic IT role.	
Kohli and Devaraj (2003)	Individual studies	1. Industry sector 2. Sample size 3. Data sources (secondary, primary) 4. Dependent variable measurements 5. Data analysis	1. Industry sector 2. Sample size 3. Data sources – primary 4. Data analysis – correlation method	Meta-analysis
Barua, Kriebel, and Mukhopadhyay (1995)	IT capital and purchases into IT	Firm-level 1. Market share 2. ROA 3. ROE Intermediate-level 1. capacity utilization 2. Inventory	Intermediate-level measures are weakly related to followings: 1. Capital utilization and inventory turnover have a positive impact on ROA 2. Relative price has	(MPIT) data that Loveman used this dataset for his study. Process analysis. Application and functional level analysis. Strategic business unit or

Authors	Independent variables	Dependent variables	Results	Comments
		turnover 3. quality 4. Relative price 5. New product introduction.	a negative impact on ROE. 3. Inferior quality, relative price, and new products are negatively related to market share.	profit center's performance.
Brynjolfsson and Hitt (1998)	IT expenditure	1. Decentralization	Higher productivity with decentralized work practice.	Firm level and inside of organizational changing work system.
Devaraj and Kohli (2000)	IT labor, capital, and support. BPR initiatives	1. Net patient revenue per day 2. Net patient revenue per patient admission	These two dependent variables are positively related to IT investments. However, the effects are more pronounced when combined with BPR initiatives	Complementarity effects Hospital setting

Since many studies are reported in Table 2.3, it is appropriate to categorize the discussion based on their similarities with regard to dependent and intervening variables studied. Scholars have explored IT impacts in terms of reductions in production costs and total expense costs (Harris and Katz, 1991; Mitra and Chaya, 1996; Dewan and Min, 1997). In general they report that IT contributes to cost reductions. However, studies at this level also suggest the presence of environmental contingencies.

Researchers have argued that although there are positive relationships between firm productivity and IT investments, the enhanced productivity is often not reflected in firm profitability measurements (Bresnahan, 1986). This is because the productivity benefits from the investment may benefit be disbursed to the firm's stakeholders. For example, in the service sector, the consumers enjoy the surplus generated by IT investments (Bryjolfsson, 1993; Bryjolfsson and Hitt, 1996; Hitt and Brynjolfsson, 1996). Therefore, these studies note positive returns from IT investments that are not captured in firms' financial statements. Brynjolfsson (1993) further argues that applying a single

measurement across different industries may not be a viable way to assess IT performance. For example, it is notoriously difficult to measure IT performance in the service sector with financial measurements such as ROA and ROE because the benefits of IT investments spread over to the consumer. Therefore, researchers should understand IT performance within its firm-specific context.

Another insight provided by work by Brynjolfsson and colleagues is in regard to the need for complementary investments. Specifically, they highlight the role of training as a *complement* to IT investments in impacting firm performance.

The studies reviewed above consider productivity impacts of IT investments in terms of gross margin, profitability ratios, and consumer surplus. Alternative measurements of productivity provide different insights. When productivity was measured by intellectual capital, a positive relationship between IT investments and productivity was noted (Bharadwaj, Bharadwj, and Konsynski, 1999).

While the studies considered above have examined the impacts of IT investments in terms of accounting metrics, another cadre of studies considers the impacts of IT investments on the stock market. These researchers have studied the impact of firms' announcements of IT investments to shareholders and the public (Im, Dow, and Grover, 2001; Dos Santos, Peffers, and Mauer, 1993). Assessing the changes in stock price following firms' announcement of IT investments, they find no excess stock market returns for the full sample (Dos Santos, Peffers, and Mauer, 1993). However, they note that innovative IT investments increase firm value while non-innovative investments do not have a similar impact on firm value. Thus, we learn that IT-enabled firm performance is technology-specific.

In another study, the announcement of IT investments made by financial firms was found to yield a higher stock market response than for manufacturing firms (Im, Dow, and Grover, 2001). Recent research re-examines data from these two event studies and provides a more in-depth insight on abnormal returns from IT investments (Dehning, Richardson, and Zmud, 2003). This study confirms findings about industry effects noted by studies employing accounting metrics: firms in the transforming industry category were found to enjoy higher abnormal returns, measured by stock prices, than firms in other industry categories. However, the authors further report that among firms in the category of transforming industry, those firms that invested in transforming IT strategic roles enjoyed much higher abnormal returns than those firms that invested in other IT strategic roles such as automate or informate up/down. Taken together, these three event studies provide two important insights into the IT productivity paradox: First, we recognize that there are industry IT strategic roles that discriminate firm performance following IT investments; second, we realize that IT investments that are transformative in nature have a higher impact on firm performance than do other types of strategic investments. The industry effect is also supported by Kohli and Devaraj's (2003) meta-analysis study.

2.1.4. Technological Imperative: Intermediate Processes

The last category of the technology imperative perspective deals with IT productivity studies employing a different research model, focusing on the relevance of intermediate productivity metrics rather than profitability metrics. For example, Loveman (1988) found no relationship between IT investments and firm performance. Re-analyzing this dataset, Barua, Kriebel, and Mukhopadhya (1995), found that IT

investments improve intermediate-level productivity (capacity utilization, inventory turnover, quality, relative process, and new product introduction). These intermediate measurements are weakly related to firm performance measured by ROA and ROE. They conclude that one of the reasons that previous IT productivity research has found inconsistent organizational impacts of IT investments is researchers' implicit employment of a black box model that does not consider the business process being supported through an IT investment.

The last discussion of Table 2.3 is the relationship between IT investments and firms' internal structures. IT investments improve firm performance for decentralized firms for those firms that had changed work systems along with the IT investment (Brynjolfsson and Hitt, 1998). The last study done by Devaraj and Kohli (2000) provides an important insight on complementary effects. This study explores the impacts of the IT investments measured by net patient revenue per day and net patient revenue per patient admission in the hospital setting. They report that although higher levels of IT investments are positively related to high firm performance, these effects are higher when hospitals invest in IT in conjunction with business process reengineering (BPR). Therefore, this study implies that complementary effects of IT investments are higher when firms change in the existing business process to reinforce the IT investments.

Overall, this literature review allows one to draw some conclusions that dispel the notion of the IT productivity paradox. First, the industry strategic IT role is related to firm performance. Some industries, such as financial services, enjoy higher levels of returns from IT investments than do others, e.g., manufacturing firms. Second, a firm's capability to exploit IT investments also impacts firm performance. Third, modeling the

direct relationship between an IT investment and intended organizational effects is critical for assessing the impacts of IT investment. For example, Loveman did not find any relationship between IT investments and firm performance, while the research model adopted by Barua et al. (1995), focusing on more proximate productivity impacts rather than profitability outcomes, allows them to observe a positive effect of IT investments with the same dataset. Finally, complementary investments are likely to prove important in leveraging the benefits of IT investments (Devaraj and Kohli, 2000).

2.1.5. Technological Imperative: Application Level

The next discussion relates to application level studies. This discussion starts with the technology imperative category. The previous studies in this category appear in Table 2.4.

Table 2.4: Application Level and Technology Imperative Studies

Authors	Independent variables	Dependent variables	Results	Comments
Srinivasan, Kekre, and Mukhopadhyay (1994)	EDI	Shipment discrepancy.	EDI technology facilitates accurate, frequent, and timely exchange of information to coordinate material movements between the trading parties.	Survey data based on the belief of representation of the JIT shipments.
Mukhopadhyay, Kekre, and Kalathur (1995)	EDI at Chrysler	1. Inventory turnover 2. Obsolete inventory cost 3. Transportation cost 4. Premium freight	1. High inventory turnover rate 2. Lower obsolete inventory. 3. Reduced premium freight. The adoption increased economic advantage for Chrysler.	Data are from Chrysler assembly centers. The subjects are users of EDI with Chrysler's suppliers over the past decade.
Lee, Clark, and Tam (1999)	EDI	1. Inventory turns 2. Stockouts	Adopters achieved a significant increased in their inventory turns while reducing stockouts.	31 grocery retail chains
Chwelos, Benbasat, and Dexter (2001)	EDI	1. Readiness 2. Perceived benefit 3. External pressure	1.External pressure – explain highest level of variance 2. Readiness 3. Perceived benefit – explain lowest level of	Data from Purchasing Managers' Association of Canada.

Authors	Independent variables	Dependent variables	Results	Comments
			variance.	
Mukhopadhyay, Lerch, and Mangal (1997)	The toll collection system.		IT implementation at the turnpike significantly increased the efficiency of processing complex transactions but not simple ones.	PA 38 toll collection systems. Its impact was isolated from specific IT applications in order to measure clear IT impacts.
Mukhopadhyay, Rajiv, and Srinivasan (1997)	IT investment (automated mail sorting machine).	Total sorting performed.	IT contributes significantly to mail sorting performance, quality, and in turn it enhances output (a higher fraction of bar-coded mail enhances productivity).	46mail processing centers over 3 years.
Alpar and Kim (1990)	Number of ATMs Number of computerized bank functions	1. ROE. 2. Installment loans 3. Real estate mortgage loans 4. Commercial and other loans 5. Demand deposit	1. Time to deposits 2. Installment loans 3. Commercial loans 4. Demand deposit.	Banking industry between 1979 and 1986

At the application level study, researchers are able to eliminate many obscuring variables so as to make the relationship between IT investment and performance relatively direct. For example, implementations of EDI have been observed to decrease shipment discrepancies, to increase Just-in-Time (JIT) shipment (Srinivasan et al., 1994), and to increase inventory turnover rate, lower obsolete inventory, and reduced premium freight costs (Mukhopadhyay, Kekre, and Kalathur, 1995; Lee, Clark, and Tam, 1999). Other application-level studies have noted positive effects of a toll collection system (Mukhopadhay et al., 1997), an automated mail sorting machine (Mukhopadhyay et al., 1999), and the installment of ATMs (Alpar and Kim, 1990) on firm performance. Especially, in observing the toll collection system, Mukhopadhyay et al. (1997) find that

IT implementation at the turnpike significantly increases the efficiency of processing complex transactions but not simple ones.

In general, application-level studies allow researchers to observe relatively direct impacts of IT investments, and accordingly show more consistent findings across studies. From these application-level studies, one can draw the conclusion that the impacts of IT investments have a positive impact on firm performance. Although application level studies provide an important insight into IT performance, the inherent problem of this level of study is that it is difficult to observe performance effects at the firm-level because the effects of such IT investments are too limited to impact firm performance. The next category of literature reviewed is the organizational imperative perspective.

2.1.6. Organizational Imperative: Firm Level

Table 2.5: Firm Level and Organizational Imperative Studies

Authors	Independent variables	Dependent variables	Results	Comments
Weill (1992)	IT investments (all hardware, software, communications, telephone and facsimile, and personnel and resources dedicated to IT)	1. Growth 2. ROA 3. Labor 4. Changes in labor	1. Transactional IT investments significantly related to ROA 2. Strategic IT investments significantly related to labor 3. Transactional IT significantly related to changes in labor	33 valve-manufacturing firms. Industry effects
Rai, Patnayakuni, and Patnayakuni (1997)	IT investment: aggregate IT, client/server systems including Internet-related systems, and IT infrastructure	Firm output measured with value added by the organization and total sales; business results, assessed using ROA and ROE of financial performance; and intermediate performance (labor productivity and administrative productivity).	IT is likely to improve organizational efficiency; its effect on administrative productivity and business performance might depend on such other factors as the quality of a firm's management processes and IT-strategy links, which can vary significantly across organizations.	Corporate business performance. *InformationWeek* surveyed Compustat's top 500 firms for data on IT budgets
Devaraj and Kohli (2003)	DSS usage (reports, processing	1. Mortality 2. Revenue per	Usage is positively related to revenue per admission	Data are from eight hospitals.

Authors	Independent variables	Dependent variables	Results	Comments
	time, number of records accessed)	admission 3. Revenue per day	and revenue per day while mortality shows a negative and weak relationship	Observed time lags Monthly data for a three-year period

The focus of the organizational imperative studies is on how managers select and deploy IT capabilities in order to achieve objectives. The two studies appearing in Table 2.5 emphasize managers' capability to deploy IT investments. Studying 33 valve-manufacturing firms, Weill (1992) reports that IT performance is contingent upon a firm's capability to convert IT investment to performance. He claims that "the key to establishing a relationship between IT investment and firm performance was the categorization of IT into the management objectives for the investment" (Weill, 1992, p. 324). A similar finding is also reported by Rai et al.'s study, which reports that although IT improves organizational efficiency, the quality of a firm's management processes and IT-strategy links are the discriminating factors for firm performance.

The last study explores IT impacts from IT usage. Based on a longitudinal study in a hospital setting, the authors observe how IT investments affect hospital performance. IT investment itself cannot be adequately measured without looking into the organizational context, e.g., how the technology is being utilized. They report that levels of technology usages are highly related to hospitals' revenue while they lower mortality rates. Also they find that there is a time-lag effect that accounts for the need for users to learn about the technology. Therefore, the driver of IT impact is not the investment in the technology, but instead the actual usage of the technology.

Therefore, scholars have observed that IT is not in itself the driving force for firm performance; instead, it depends on what type of technology is selected by manager

(Weill, 1992) in relation to the firm's strategy (Rai et al., 1997) and how it is used (Devaraj and Kohli, 2003).

2.1.7. Summary of IT Investments and Firm Performance

This section has reviewed previous IT productivity studies based on technological and organizational imperatives and the level of analysis. The IT imperative perspective has been a dominant research interest in this area. It may be due to the fact that there are persistent inconsistent findings across studies and thus scholars have attempted to resolve the problem using a different modeling or a research sample. Although there are some inconsistent findings, the literature review has some important insights. As discussed, first, one cannot simply expect a positive relationship between IT investments and firm performance; instead, it is firm's capability to exploit the investments.

Second, different industries possess different levels of capability to lever IT opportunities because some industries (e.g., transforming industry) heavily rely on IT for their survivability and profitability, while some industries' (e.g., automating industry) strategic plans and firm profitability may not be heavily derived from a strategic IT deployment. Further, not all industries are equally blessed with IT capability.

Third, researchers should select the right research model when examining the relationship between IT investments and firm performance. For example, Loveman's study measures the relationship between IT expenditure and firm performance, and reports no relationship. However, when Barua et al. (1995) use intermediate variables such as capacity utilization, inventory turnover, and quality, and related them to firm performance such as market share, ROA, and ROE, they are able to find a positive

relationship. Therefore, researchers should develop a viable research model in order to measure the impact of IT investment.

Fourth, there are too many intervening and confounding variables in the firm level study. This is one of the main reasons that scholars have reported inconsistent findings at the firm level. Especially, this problem is severe when a researcher designs a model at the national level. However, these problems are significantly reduced with application level studies. For this reason, research findings of this level of studies have been relatively consistent.

Lastly, but most importantly, in spite of numerous IT productivity studies, little attention has given to significant roles of complementarity in firm performance. Recent challenge to IT productivity research is not whether IT pays off but rather under what conditions does it pay off? Inclusion of the concept of complementarity may provide insights on this issue. This is an important construct that has been studied in economics but has not been efficiently incorporated into IT productivity studies. The following section introduces the concept of complementarity.

2.2. Complementary Investments and Firm Performance

In an effort to address the IT productivity paradox problem, scholars have explored the concept of complementarity in IT outlays. This may provide additional insights into the nature of IT productivity (Barua et al., 1996; Barua and Mukhopadhyay, 2000). *Complementarity refers to investments that reinforce one another*. The concept of complementarity was initially introduced by Adler (1988) and theoretically expounded by Milgrom and Roberts (1990), who discussed it within a manufacturing context. Researchers in IT have adopted this concept for IT performance studies (e.g., Barua et al.,

1996; Powell and Dent-Micallef, 1997; Barua and Mukhopadhyay, 2000). Tables 2.6 and 2.7 identify the elements of complementarity that have been identified in previous literature.

This discussion of complementarity is organized based on the two categories appearing in Tables 2.6 and 2.7 – organizational-level and application-level studies. This categorization highlights the different scope of complementary investments that may be required in different types of studies – that an organizational-level study of IT investments may require an organizational-wide view of complementarity, while an application-level study may demand a local view of complementarity. The explanation of complementarity provided by Milgrom and Roberts will be discussed in detail as this is the first study to theorize the concept of complementarity.

Table 2.6: Elements of Complementarity – Organization Level

Authors	Characteristics	Context
Milgrom and Roberts (1990)	♦ New manufacturing technology accompany changes in: o Inventory policy o Product market strategy o Supplier and customer relations	Manufacturing firm
Adler (1988)	♦ Human resources – training	Automation
Snell and Dean (1992)	♦ Human capital – skill and knowledge o Hiring o Training o Rewards	Integrated manufacturing (advanced manufacturing technology, total quality, and just-in-time)
Hitt and Brynjolfsson (1997)	♦ Decision authority ♦ Human capital ♦ Incentives (team)	IT investment. 273 large firms from *Fortune 1000* (services, manufacturing, mining, construction) – survey method
Powell and Dent-Micallef (1997)	♦ Technology (home office/store communications, distribution center inventory management, distribution center communications, EDI, home office marketing) ♦ Human resources (open organization, open communications, consensus, CEO commitment, flexibility, and IT/strategy integration) ♦ Business resources (supplier relationship, supplier-driven IT, IT training, process design, teams, benchmarking, and IT	Retail industry

Authors	Characteristics	Context
	planning)	
Barua, Lee, and Whinston (1996)	♦ Technology ♦ Decision authority ♦ Business process ♦ Incentives	Business process reengineering
Brynjolfsson, Renshaw, and Alstyne (1997)	♦ Flexible technology ♦ Cross-training ♦ Incentives ♦ Inventory policies (JIT) ♦ Decision-making structures (line rationalization – top down optimization) ♦ Open-door communication	Medical products manufacturer
Tanriverdi and Ruefli (2004)	♦ Complementary investments are additive within group and multiplicative across groups ♦ Four levels of complementary investments ♦ Input factors ♦ Activities ♦ Groups of activities ♦ Firm strategy	Theoretical piece. Complementary investments are context-specific

Milgrom and Roberts (1990) specify direct and multiplicative effects of investments. The direct effect refers to the relationship between an investment and its performance, and the multiplicative effect is the notion of complementarity, referring to the interactive effects of groups of activities on performance. In their study, investments in CAD/CAM and flexible manufacturing equipment are each noted to have a direct effect on firm performance. However, integration of these two investments creates a multiplicative effect, i.e., a complementarity, whereby the returns on the combined investments exceed the returns on individual investments alone. Here, the benefits of complementarity arise from the reduction of designing costs of new products, the improvement of product quality, shorter production runs, lower inventories, and more frequent product redesign. However, complementarity extends to a broader level of organization impacts such as marketing, engineering, and organizational structure. Marketing divisions change their marketing strategies to accommodate fast delivery, frequent introduction of new products, and lower prices resulting from the adoption of the

technology. On the engineering side, CAD reduced the design time and allowed firms to evaluate a broader range of potential designs. Manufacturing firms change their organizational structure to reflect the way they interacted with customers, employees, and suppliers. Firm economize on inventory costs (such as interest, storage, and obsolescence) by scheduling production in a way that is responsive to customer demand. These variables tend to increment the direct effects because the corresponding relationships are ones of "complementarity."

Extending the work of Milgrom and Roberts, Tanriverdi and Ruefli (2004) elaborate on the relationships between complementary inputs and activities. Complementary input investments are activity-specific, i.e., the value of inputs is relevant within the context of a specific activity, e.g., new product development or flexible manufacturing activities. For example, Tanriverdi and Ruefli point out, it is difficult to assess whether inputs of CAD/CAM, distance learning, and automated production equipment are complementary unless they are considered within the context of *activities* such new product development or flexible manufacturing. In these contexts, CAD and CAM empower production employees, and distance learning facilitates these employees' training and coordination in different locations. Tanriverdi and Ruefli further specified four levels of complementarities: at the first level are inputs such as technology or skills; at the second level, organizational capabilities integrate these inputs; at the third level, groups of complementary activities deliver value to internal customers; the fourth level is the firm's strategy that identifies the groups of complementary activities. Within each level, the effects of these complementary elements are additive, where increases in levels of one element may reduce the amount of another element required correspondingly.

Across levels, elements "fit" with each, where the nature of the investments made at one level need to match those at another.

Milgrom and Roberts' concept of complementarity did not include human capital. Although Adler's (1988) work identified the importance of human capital before the work of Milgrom and Roberts, it had not been efficiently incorporated in the discussion of the concept of complementarity until recently (Snell and Dean, 1992; Hitt and Brynjolfsson, 1997; Powell and Dent-Micallef, 1997). Other complementary elements appearing in Table 2.6 are decision authority (Barua et al., 1996; Brynjolfsson et al., 1997) and incentive systems (Hitt and Brynjolfsson, 1997). These three complementary elements are discussed below.

Human capital includes employees' skills, experience, and knowledge that have economic value to firms (Snell and Dean, 1992). Adler criticizes the fact that firms view the impacts of human capital as a low priority, while rigorously assessing technical capabilities and cost savings. He argues that "work force capabilities are themselves a critical competitive resource … but almost never plays the kind of role in strategic or even operating plans that it should command" (Adler, 1988, p. 46). These arguments suggest that IT investments alone cannot be competitive resources; they should be complemented by investments in human capital.

Human capital investments refer to employee training (Alder, 1988; Snell and Dean, 1992; Brynjolfsson et al., 1997) and staffing practices (Snell and Dean, 1992). Training is one of the most important elements of traditional human resources management. It is particularly important following the deployment of a new technology because as technology changes, employees should be familiar with the capabilities of the

new technology. As Adler noted though, firms tend to prioritize technical issues such as debugging rather than employee training. However, unskilled employees drain the value of a firm's IT investment by wasting time and effort (Snell and Dean, 1992). Training has been found to have a positive impact on IT-related firm performance (Brynjolfsson et al., 1997)

Staffing is another important factor in human resource management, although not many complementarity scholars have emphasized this aspect of human capital. While on-the-job training is important, firms may not be able to exploit economic value from human resources if they do not hire competent employees (Snell and Dean, 1992).

Decision authority has also been noted to complement to IT investments (Barua et al., 1996; Brynjolfsson et al., 1997). The location of decision authority is important to reaping the benefits of IT investments because the appropriate location of decision rights enables those with specific knowledge, which is difficult to convey to others and expensive to transfer, to make necessary decisions (Hitt and Brynjolfsson, 1997). When decision-making is thus decentralized though, it is also important to re-align incentive systems. The utilization of knowledge specific to local issues makes it difficult for management to ensure that the decisions that are made benefit the firm. Concurrent re-engineering of decision rights and incentive systems is therefore necessary in order to garner the benefits of the IT investment. Organization-level studies that focus on this last element of complementarity are summarized in Table 2.6 (Hitt and Brynjolfsson, 1997).

These arguments about the necessity for concurrent attention to the location of decision rights and to incentive systems are consistent with agency theory: when decision authority is decentralized, agency problems arise. The final (principal) decision-maker

cannot tell whether local decision makers (agents) are making the right decision for the firm. It is especially difficult when 'specific' knowledge is involved because the principal is unable to evaluate the consequences of the decision at the moment of the decision. In such cases, outcome-based incentive systems that do not require a priori understanding of the decision processes, but focus on the outcome from aggregated decisions, are more likely to be effective.

Table 2.7: Elements of Complementarity - Application Level

Authors	Characteristics	Context
Barua, Lee, and Whinston (1995)	♦ Incentives (reward systems) ♦ IS design (partial or total anonymity) ♦ Organizational and task characteristics (interdependence)	GDSS
Ba, Stallaert, and Whinston (2001)	♦ Incentive systems	DSS, knowledge management, and e-business supply chain coordination
Davern and Kauffman (2000)	♦ Infrastructure ♦ Business process design – incentive ♦ Human capital ▪ User training ▪ Management skills	Revenue yield management DSS
Barua and Whinston (1998)	♦ Streamline processes ♦ Information access ♦ Employee skills ♦ Restructure decision authority ♦ Management control processes	DSS
Fan, Stallaert, and Whinston (2003)	♦ Decentralized IS ♦ Incentive systems in the decentralized organization structure	Supply chain information systems

The salient complementary elements of IT investments appearing in application-level studies are incentive systems, human capital, decision authority, natures of task, and infrastructure (see Table 2-7). Since incentive systems, human capital, decision authority were discussed in the context of organizational-level studies, they will not be repeated here. Therefore, this discussion will focus on the nature of the task and infrastructure.

The nature of the task refers to the degree of interdependence or autonomy inherent in the task (Barua et al., 1995). When a task is interdependent and when it is

difficult to assess an individual's contribution to outcomes, productivity is not high (e.g., Mintzberg, 1973) as individuals are not structurally motivated to contribute their best efforts due to the unobservable nature of their independent contributions to the final outcome. Therefore, the nature of the task should be complemented with an appropriated incentive system (Barua et al., 1995).

Infrastructure has been recognized as an important complementary element in the application-level studies (Davern and Kauffman, 2000). Researchers argue that failure to invest in infrastructure as a complementary asset to leverage and integrate a new application will result in reductions in the realization of the IT investment potential.

In summary, the scope of the complementarity construct in firm- and application-level studies is not different. The nature of the task is recognized in organizational-level studies as well (Barua et al., 1996), though not as extensively as it was at the application level. Technological infrastructure is the only complementary factor that appears in application-level studies but not in organization-level studies. With this factor too, it is expected that firm-level IT investment assessments will manifest complementarity effects with infrastructure by virtue of the necessity for an appropriate infrastructure to transfer information across different units. Since IT functions and capabilities are more complicated as technology develops, and since IT functions tend to cross multiple divisions, IT infrastructure should receive more attention in organizational-level studies than it has to date. Failure to invest in infrastructure necessary to integrate new applications may result in reduction in the benefits of the investments (Daven and Kauffman, 2000).

2.3. Complements of IT Investments

Discussions about organizational and technological elements that complement IT investments have centered around design rules, relationships, and education and training. This section reviews previous IT and organizational literature that has discussed types of complementary investments.

2.3.1. Design Rules

Design rules bring "about a coherence between the goals or purposes for which the organization exists … inter-unit coordination and the people who will do the work" (Galbraith, 1977, p. 5). These rules are designed to facilitate the flow of information to enhance the value from the focal IT investment. Table 2.8 shows the previous research on technical and business design rules.

Table 2.8: Previous Literature on Design Rules

Category	Authors	Characteristics
Technical Design Rules	Frels, Shervani, and Srivastava (2003); John et al.(1999); Sanchez (1999, 1995); Brynjolfsson and Kemerer (1996)	♦ Modularity ♦ Component standardization
	Garud and Kumaraswamny (1995)	♦ Integrity ♦ Modularity ♦ Upgradability
	Mihm, Loch, and Huchzermeier (2003)	♦ Local optimization ♦ System-wide optimization
	Baldwin and Clark (2000)	♦ Architecture ♦ Interface
	Sanchez and Mahoney (1996)	♦ Product architecture – a complete set of component interface specifications. o A modular product architecture is an efficient architecture
Business Design Rules	Sanchez and Mahoney (1996)	♦ Embedded coordination (through standardized component interface) ♦ A modular organizational form is designed based on o Specific activities or tasks o Activities interact according to rules.
	Adler (1996)	♦ Standardized rules
	Lei, Hitt, and Goldhar (1996)	♦ Loosely coupled modular form of organization

Category	Authors	Characteristics
		♦ Economies of scale
	Raynor and Bower (2001); Hitt and Brynjolfsson (1997)	♦ Decentralized decision

Technical Design Rules

Technical design rules facilitate coordination of technical investments into a cohesive system. Such integration is best accomplished through modularization. A module is a unit whose elements are strongly connected among themselves but weakly connected to the elements of other units. Modular design enables designers of socio-technical systems to easily substitute certain components while retaining others (Garud and Kumaraswamy, 1995), thereby reducing the time and cost required to implement changes to existing system designs (Baldwin and Clark, 2000) and enabling firms to respond to rapidly changing environments. A modular form of organization facilitates each unit's accumulation of knowledge most salient to its local environment (Mahoney, 1992; Orton and Weick, 1990).

Modularity reduces ripple effects, for example, in software development, a bug in one module appearing as a symptom in another module (Page-Jones, 1980, p. 102). It buffers the system from other subunits and provides adaptability to fragmented environments. Another benefit is in coping with rapidly changing environments (Eisenhardt and Brown, 1999). Modularity allows firms to quickly respond to fragmented environments and allow units to have behavioral discretion within a unit.

Positive spillovers or externalities of component standardization [modularity] accelerate the rate of progress among users and producers (John et al., 1999). The benefits of spillovers are the dissemination and use of tacit knowledge (John et al., 1999; Garud and Kumaraswamy, 1993). Externalities in the creation of tacit knowledge and its

dissemination create demand-side increasing returns in technology intensive markets (John et al., 1999). Further, a larger market size creates lower costs from increased economies of scale and from competition. The increasing returns often are located in complementary products or peripherals, such as software for computers or prerecorded cassettes for videotape machines. Industry standardized components also create positive network externalities in technological learning (Sanchez, 1999) and it is a key factor for adoption of innovation (Schilling, 2002). One example of positive component externalities is that the users rated Unix better than NT but the adoption of NT was higher than Unix due to externality (Frels et al., 2003).

Another advantage of component standardization is in software pricing. For example, network externalities have been found to significantly increase the price of spreadsheet products that adhered to the dominant standard (Brynjolfsson and Kemerer, 1996). The internal advantages of modularity are the following: it can be easy to customize products towards different customer segments, easy to introduce new products with low prices and low risks, and it enhances the reusability of different parts. A carefully designed technical design is crucial steps toward successful exploitation of IT resources.

Business Design Rules

Business design rules involve a flexible organizational design that enables firms to take advantages of the capabilities of the technology, which can be best achieved through modular structures (Lei et al., 1996) and decentralized decision-making (Hitt and Brynjolfsson, 1997). Like technological modularity, business modularity can design a structure based on work, tasks, or outputs (Worren et al., 2002; Sanchez and Mahoney,

1996). Especially when environments are uncertain, this form of an organizational structure is desirable (Thompson, 1967). This modular form of organization involves the use of relatively independent divisions through embedded coordination, standardized rules rather than managerial authority (Adler, 1996, Sanchez and Mahoney, 1996), which reduces the required amount of information transfer and allows each division autonomy in its work processes (Woolsey, 1994).

Decentralized decision-making also allows each division to exercise a certain amount of autonomy and enables firms to take advantages of local information. Decentralized decision-making is an especially efficient organizational design when a firm operates in fragmented environments that require prompt responses, and when such responses require accumulated knowledge. Such organizational forms are especially suitable in markets that rely on product customization and responsiveness by leveraging time-critical, difficult-to-communicate information held by line workers (Hitt and Brynjolfsson, 1997). Such knowledge is difficult to transfer because it is embedded within the work processes, which von Hippel (1998) called 'sticky local information." This knowledge is relatively immobile (Attewell, 1992). If this information has to cross many levels of hierarchy within an organization, the final decision maker may not have the 'absorptive capacity' to interpret the given information (Cohen and Leventhal, 1990). Therefore, in order to relieve the information overload and to increase the likelihood that decision makers have sufficient absorptive capacity, decision rights are given to those individuals that possess sufficient information for decision making (Jensen and Mecking, 1992). Appropriately designed decision rights positively impact firm performance by

allowing those employees who have real-time information make decisions (Eisenhardt, 1989).

2.3.2. Relationships

Interpersonal relationships serve as pathways to access to information and knowledge leverage value from the focal investment (e.g., Hansen, 1999; Uzzi, 1996). Table 2.9 shows previous literature on IT-based and organizational relationships.

Table 2.9: Previous Research on Relationships

Dimension	Authors	Characteristics
IT-based relationships	Grover, Teng, and Fiedler (2002)	♦ Collaborative IT between buyer and supplier ▪ Trust
	Hart and Saunders (1997)	♦ Buyer and supplier relationships through EDI ▪ Trust ▪ Power
	Holland and Lockett (1997)	♦ Network technology and cooperative relationship ♦ Market complexity requires high levels of coordination
	Petersen, Ragatz, and Monczka (2005)	♦ Collaborative planning and trust
	Kraut, Steinfield, Chan, Butler, and Hoag (1999)	♦ Coordination with suppliers through electronic networks increased with interpersonal relationships ♦ Personal linkages increased better outcomes
	Goodhue et al., (2002)	♦ Data standardization
	Sawhney, 2001	♦ Data synchronization
	Reich and Kaarst-Brown (1999)	♦ Transferring IT personnel to other divisions
	Armstrong and Sambamurthy (1999)	♦ Relationship between the CIO and the top management team
	Feeny et al., 1992	♦ Two way relationships
	Watson (1990)	♦ Relationship (communication) with the CEO ♦ IS managers are influenced by peers (discussion with other professionals)
	Lederer and Sethi (1988); Lederer and Mendelow (1987); Mcfarlan (1971)	♦ Communication with the top management team
Organizational Relationships	Nahapiet and Ghoshal (1998)	♦ Organizations offer the four critical conditions of social capital ▪ Time –stability and continuity ▪ Interaction ▪ Interdependence - dependent on each other ▪ Closure – boundary ♦ Social capital facilitates the development of intellectual capital (knowledge creation)

Dimension	Authors	Characteristics
	Granovetter (1973); Uzzi (1997); Hansen (1999); Ahuja (2000); Stuart (1998)	♦ Different types of knowledge and information transfer is related to different types of networks ▪ Strong ties – search information ▪ Weak ties – transfer complicated knowledge
	Jarillo (1988)	♦ Interorganizational networks ▪ Trust is a critical component of network ▪ Members share valuable information
	Uzzi (1997)	♦ Social capital among Garment companies ♦ Trust ♦ Get access to valuable market information
	Dyer and Singh (1998)	♦ A firm's critical resources reside in firm boundaries ▪ Relational-specific assets ▪ Knowledge-sharing routines ▪ Complementary resources and capabilities
	Nambisan (2002); McEvily and Zaheer, (1999); Yli-Renko (2001)	♦ Customer relations ♦ New product development ♦ Social interactions with customer ♦ Knowledge acquisition
	Liebeskind, Oliver, Zucker, and Brewer (1996)	♦ In biotechnology industry, the role of boundary spanning increases follows: ▪ Learning ▪ Flexibility
	Cross and Prusak (2002); Cross, Nohria, and Parker (2002)	♦ Central connectors – within units or divisions ♦ Boundary spanners ♦ Information brokers – different subgroups ♦ Peripheral specialists – specialized expertise
	Cross, Parker, Prusak, and Borgatti (2001)	♦ Knowing what another person knows and when to turn to them ♦ Being able to gain timely access to that person ♦ Willingness of the person sought out to engage in problem solving rather than dump information ♦ A degree of safety in the relationship that promoted learning and creativity
	Sparrowe, Liden, Wayne, and Kraimer (2001)	♦ Advice networks ♦ Hindrance networks

IT-based Relationships

IT-based relationships are enabled by collaborative technologies (e.g., EDI, VMI) that connect organizations. However, technology alone is insufficient in such relationship; trust is integral to the transfer quality information and knowledge. For example, although EDI enables firms to transfer information, effective use of IT for inter-firm coordination requires established relationships and trust (Hart and Saunders, 1997).

Trust increases the probability of expanded information sharing through EDI and the likelihood the partners will explore new mutually-beneficial arrangements that improve inter-firm coordination (Hart and Saunders, 1997).

IT-enabled inter-firm relationships can be further instantiated by individual members who serve as boundary-spanners for their firms (Kraut et al., 1999). These relationships have been found to predict individuals' use of their electronic networks to coordinate production (Kraut et al., 1999). Therefore, personal relationships also facilitate usage of collaborative technologies.

Relationships in IT literature also address issues of data standardization and employee interactions. A standardized data format serves as a means to integrate different technical functions and to facilitate the flow of information and knowledge across subunits. Synchronized data, in particular, improve communication on a real-time basis, and enable employees to discuss problems together with the same information. Through data synchronization, firms can present a single and unified face to the customer, and thus enhance customer relationships, which often lead to higher customer satisfaction and product sales (Sawhney, 2001).

Employee interactions considered in the literature are those among employees and those between the top IT manager and other executives. Interactions among employees serve as a means for transmitting information about technological innovations, which lead to adoption (Burkhardt and Brass, 1990). They also facilitate a successful implementation of a focal IT. For example, employees who move from the IT department to other functional areas have been found to serve as a facilitator of IT implementation (Reich and Kaarst-Brown, 1999).

Relationships between the CIO and the CEO and other members of the top management team also contribute value of IT implementation. The presence of the CIO on the top management team or their direct communication with the CEO creates an informal relationship, which allows them to discuss opportunities for IT to contribute value to the firm (Armstrong and Sambamurthy 1999; Feeny et al., 1992; Feeny and Wilcocks, 1998). A close informal relationship between the CIO and the CEO promotes a business and technology fit, which in turn enhances firm performance (Watson, 1990).

Organizational Relationships

Research on organizational relationships has considered inter- or intra-organizational relationships. Inter-organizational relationships have been found to facilitate knowledge transfer and creation through shared norms and understandings (Nahapiet and Ghoshal, 1998). They facilitate organizational learning in dynamic environments (Liebeskind et al., 1996). Since such relationships are based on trust (Uzzi, 1997; Jarillo, 1988), they tend to exclude those outside the relationship from the benefits of the relationship; hence such relationships can serve as strategic resources that enhance firm performance (Jarillo, 1998). Therefore, it is important to develop organizational relationships that can complement the focal firm's capability and needs (Dyer and Singh, 1998). Such relationships provide opportunities for firms to access their partners' technological resources and knowledge and allow firms to co-invest resources in ways that complement each other's capability (Dyer and Singh, 1998).

Research has also explored the significance of organizations' relationships with their customers (Nambisan, 2002; Yli-Renko, 2001). Customers serve as an important resource in terms of providing ideas about or problems of new products. This

information, in turn, facilitates product innovation. Furthermore, loyal customers can be tapped to gain access to a broader set of customers or provide the organization with assistance in co-opting potential customers (McEvily and Zaheer, 1999).

The organizational literature on relationships has also considered emphasized intra-organizational relationships (e.g., Cross and Prusak, 2002). Specifically, this work has identified different roles played by organizational members in the transfer and use of knowledge. *Central connectors* facilitate disseminating information and knowledge *within the firm*. *Boundary spanners* play an important role in situations where people need to share different kinds of expertise – for instance, in establishing connections between new product development practices and customers' needs and wants, or even with academia. *Information brokers* connect subgroups that they may not be linked to the focal group. *Peripheral specialists* commonly reside outside of networks but have expert knowledge. They tend to possess specific kinds of information or technical knowledge such as research data, software skills, or customer preferences.

As with inter-organizational relationships, intra-organizational relationships also provide significant benefits (Cross et al., 2001). Employees in an organization are more likely to get information from their personal contacts than any other sources such as the Internet or PC archives (Cross et al., 2001). Therefore employees' number of networks is important for firm performance. For example, employee groups with multiple network ties outperform those with few (Erickson and Jacoby, 2003). Through the informal meetings, UPS drivers have been noted to exchange valuable information and strategies for dealing with mis-sorted packages or workloads (Prusak and Cohen, 2001). Also

relationships can provide benefits and disadvantages to the organization depending on the role of the network (Sparrowe et al., 2001).

2.3.3. Education and Training

Table 2.10 shows literature that has discussed technological and business training.

Table 2.10: Education and Training

Assets	Authors	Characteristics
Education and Training in IT Literature	Yi, Davis, and Fred (2003); Sanders and Courtney (1985)	♦ Training
	Nelson and Cheney (1987)	♦ End-user training
	Davis and Bostrom (1993)	♦ Training (two different methods)
	Magal, Carr, and Watson (1988)	♦ Critical success factors for information center managers include o End-user training o Training for information center staff
	Teo and Ang (2001)	♦ Hiring personnel ♦ Hiring consultants
	Davern and Kauffman (2000)	♦ Training
	Applegate and Elam (1992)	♦ Career development program for IT managers ♦ School curriculum designed for future IS managers and leaders
	Molina and Ortega (2003)	♦ Training
	Hitt, Bierman, Shimizu, and Kochhar (2001)	♦ Knowledge o Formal education o Learning on the job and prior training o Partner firms' firm specific knowledge
	Roepke, Agarwal, and Ferratt (2000)	♦ IT leadership o Hiring personnel
	Becker (1993)	♦ General human capital ♦ Special human capital
Education and Training in Organizational Literature	Buchholtz, Ribbens, and Houle (2003)	♦ Firm-specific human capital o CEO tenure ♦ Industry-specific human capital o Relatedness
	Combs and Skill (2003)	♦ Managerial skills o Leadership skills o Firm-specific knowledge for decision-making o Experience
	Molina and Ortega (2003);	♦ Training
	Roepke, Agarwal, and Ferratt (2000)	♦ IT leadership o Hiring personnel
	Becker (1993)	♦ Special human capital
	Snell and Dean (1992)	♦ Selective staffing ♦ Comprehensive training ♦ Developmental appraisal ♦ Equitable rewards
	Becker (1962)	♦ On-the-job training

Assets	Authors	Characteristics
		♦ Schooling ♦ Information about job ♦ Improving emotional and physical health

As shown in Table 2.10, the concept of knowledge and training is broader than has been discussed in the complementarity literature. Notably, the table shows that the scope of knowledge and training has been mainly researched at the organizational level rather than a specific application-level investment. Training and staffing appear as common factors across studies. Although leadership is an important component of human capital appearing in Table 2.10, the construct is considered later as an enterprise-level capability.

Training has been the traditional focus of human capital theory and leads to improvements in firm performance (Becker, 1962; Schultz, 1960). It allows employees to learn new job skills and techniques that are directly related to firm performance. Training is especially important when an organization changes its identity and has to redirect the focus of the nature of work. There is a positive relationship between training and product quality, which results in higher levels of firm performance (Youndt et al., 1996), and between training and firm performance (Snell and Dean, 1992; Erickson and Jacoby, 2003). Technical training allows employees to learn technological skills and methods that enable them to perform IT-related tasks. Training ensures that everyone has a common basis of technology and adequate understanding of process (Ward and Peppard, 2002). Customer relationship training also improves customer satisfaction, which in turn results in high firm performance (Pugh, 2002) or a direct positive relationship between training and productivity (Yi et al., 2003).

Recruiting competent personnel as a part of human capital has been recognized as one of the important factors in enhancing firm performance (Snell and Dean, 1992; Roepke, Agarwal, and Ferratt, 2000). If firms wish to succeed in today's global business environment, they have to focus on acquiring employees who possess better skills and capabilities than their competitors (Pfeffer, 1994). Although training is important, selecting competent employees who can absorb the training is important. In rapidly changing environments, low-ability employees consume more time and effort to understand the work requirements necessary for productivity than do high-ability employees, which in turn leads to low training costs for high-ability employees (Snell and Dean, 1992). The importance of staffing appears in IT implementation literature. Not having qualified IT personnel often results in failure of IT implementation (Teo and Ang, 2001). Hiring experienced professionals early in the software development life cycle is likely to have the success of a project (Davern and Kauffman, 2000). 3M selects employees from its student interns who demonstrate their abilities during their internship periods (Roepke et al., 2000). 3M reports that this has been a very successful staffing strategy. Therefore, firms adopt proactive strategies in selecting employees.

Acquiring and retaining employees with the appropriate abilities complements the focal investments because a firm should have these resources for firm performance but how to harness the benefits of a focal investment depends on a firm's capability to manage its human capital.

2.3.4. Summary of Complementarity Investments and Firm Performance

The literature review provides interesting observations. First, theoretical development of the concept of complementarity is disjointed, with constructs having been

included in a seemingly random manner. Second, despite the absence of theoretical justification for the inclusion of additional constructs, there are some constructs that have consistently emerged across studies. Among them, human capital, incentive systems, relationships, and decision authority are emerged as complementary investments with technology. Third, the importance of technological infrastructure has received little attention, despite its becoming recognized as one of the most important factors for implementing emerging technologies (Broadbent and Weill, 1997).

2.4. Enterprise-Level IT Management Capability

Enterprise-level IT management capability refers to *the firm-level potential for exploiting strategic and operational IT opportunities to enhance performance.* This capability enables a firm to effectively leverage its IT investments, and includes top management's commitment to IT, IT management capability, and capability to align IT and business strategies. Table 2.11 shows previous literature on each construct.

Table 2.11: Enterprise-Level IT Management Capability

Authors	Characteristics	Impacts
Top Management's Commitment to IT		
Doll (1985)	♦ Top management involvement	♦ IS development efforts
Kwon and Zmud (1987)	♦ Top management support	♦ Strategic IT planning
Earl (1993)	♦ Top management support ♦ Top management involvement ♦ Sufficient resource allocation	♦ Strategic information systems planning
Lederer and Sethi (1988)	♦ Top management commitment	♦ Strategic information systems planning ♦ IT expenditure
Thong, Yap, and Raman (1996)	♦ Top management's commitment to IT	♦ User satisfaction ♦ Overall IS effectiveness (user satisfaction)
Lewis, Agarwal, and Sambamurthy (2003)	♦ Top management commitment	♦ Perceived usefulness
Sabherwal (1999)	♦ Integration o Top management participation	♦ Successful IS planning ♦ Top management's IT knowledge
Teo and Ang (2001)	♦ Top management support	♦ IS planning
Meador, Guyote, and Keen (1984)	♦ Top management emphasis	♦ DSS language adoption by users
Sanders and Courtney	♦ Top management support	♦ DSS success

Authors	Characteristics	Impacts
(1985)		
Jarvenpaa and Ives (1991)	♦ Top management team's involvement ♦ Top management team's participation	♦ Firm's progressive use of IT
Boynton, Zmud, and Jacob (1994)	♦ Managerial IT knowledge	♦ IT use o Cost reduction o Management support o Strategic planning o Competitive thrust
Feeny, Edwards, and Simpson (1992)	♦ CEO's attitude (involvement) o CEO perception of industry IT o CEO personal experience with IT	♦ CIO/CEO relationship ♦ Industry effects (Vision to transform)
Jarvenpaa and Ives (1990)	♦ CEO's letters to the shareholders	♦ Industry effects ♦ High profits as a percentage of sales
Weill (1992)	♦ Top management support	♦ Productivity conversion effectiveness
Luftman and Brier (1999)	♦ Senior executive supports for IT ♦ Leadership	♦ IT and business alignment
IT Management Capability		
Applegate and Elam (1992)	♦ Leadership skills ♦ Knowledge ♦ Experience	♦ Successful IS executives
Boynton, Zmud, and Jacobs (1994)	♦ Managerial IT knowledge	♦ IT use
DeLone (1988)	♦ Top management knowledge about computers ♦ Top management involvement in computerization	♦ Successful computer use in small business
Fichman and Kemerer (1999)	♦ Knowledge	♦ IT assimilation
Armstrong and Sambamurthy (1999)	♦ Senior members' IT and business knowledge	♦ IT assimilation
Reich and Benbasat (1990)	♦ CEO support ♦ CEO knowledge on IT values	♦ Developing a customer-oriented strategic system as a first mover
Clark, Cavanaugh, and Brown, and Sambamurthy (1997)	♦ People skills ♦ Reward systems	♦ Change-readiness capabilities
Johnston and Carrico (1988)	♦ CEO support ♦ Leadership ♦ Top manager's knowledge on IT and its potential	♦ Industry effects ♦ Higher levels of capability to exploit market opportunities and develop internal capability in Type 3 or integrated companies
Strategic Alignment		
Sabherwal and Kirs (1994)	♦ Critical success factors ♦ IT	♦ IT success ♦ Organizational performance (school setting)
Chan and Huff (1993)	♦ Fit	♦ Organizational performance
Bensaou and	♦ Information-processing needs	♦ Performance measures

Authors	Characteristics	Impacts
Venkatraman (1996)	♦ Information-processing capabilities	Supplier ratings Satisfaction Four buffer levels ♦ Equifinality
Chan, Huff, Barclay, and Copeland (1997)	♦ Business strategy ♦ IS strategy	♦ IS effectiveness
Palmer and Markus (2000)	♦ Quick Response	♦ Performance is not high
Sabherwal and Chan (2001)	♦ Business strategy (defender, analyzer, prospector) ♦ IT strategy (efficiency for defender, comprehensiveness for analyzer, and flexibility for prospector)	♦ Perceived business performance is higher for prospector and analyzer

2.4.1. Top Management's Commitment to IT

Top management's commitment to IT has long been recognized as one of the most important IT implementation factors for strategic IT planning and firm performance (e.g., Weill, 1992; Meador et al., 1984). Scholars see it as "the chief executive's role in IT activities … encompass both participation and involvement" (Javenpaa and Ives, 1991, p. 206); "top management's role in providing guidance for information systems development activities" (Doll, 1985, p. 17), and "the managerial efforts associated with planning, organizing, controlling, and directing the introduction and use of IT within an organization" (Boynton, Zmud, Jacobs, 1994, p. 299). Following Boynton et al., this construct refers to the *top management's commitment associated with planning, organizing, controlling, and directing the introduction and use of IT within an organization.* The top management refers to those who decide the organization's future. These are the CEO, COO, CIO and other senior business executives who are formal members of the top management team of a firm (Armstrong and Sambamurthy, 1999). As shown in Table 2.11, the top management team's commitment has a positive impact on strategic IT planning (Doll, 1985; Kown and Zmud, 1987; Earl, 1993; Lederer and

Sethi, 1988; Teo and Ang, 2001; Sabherwal, 1999), strategic use of IT (Jarvenpaa and Ives, 1991; Feeny et al., 1992; Sanders and Courtney, 1985; Meador et al., 1984), user satisfaction (Thong et al., 1996), economic performance (Jarvenpaa and Ives, 1990; Weill, 1992), and IT/business strategic alignment (Luftman and Brier, 1999).

It is clear from the literature review above that securing top management's commitment to IT is critical to successful IT implementation because it impacts the level of IT expenditure (Lederer and Sethi, 1988) and signals the importance of strategic role of IT to the employees (Javevpaa and Ives, 1990). When the CEO or top managers are involved with IT planning and/or implementation enough funding is more likely to be appropriated toward for strategic IT implementation (Thong et al., 1996; Earl, 1993). Projects often fail because of a lack of sufficient funding (Teo and Ang, 2001; Ein-Dor and Segev, 1978). Therefore, top management commitment to IT projects determines to a large extent whether IT project implementation will be successful or not (Thong et al., 1996).

An efficient way of securing funding is for top managers to understand the strategic role of IT. In order to understand the strategic role of IT, it is important to have interaction between the CIO and the top management team (Feeny et al., 1992). Such interaction provides the top management team with knowledge about the strategic role of IT. It also ensures that the IT function is cognizant of the needs of the business. Interaction between the top management team and the CIO therefore creates knowledge overlaps among business and IS function and frequently results in long-term business plans that involve IT (Sabherwal, 1999; Lederer & Mendelow, 1989; Lederer & Sethi,

1996; Ward et al., 1990). Therefore, top management's commitment to IT leads to successful IT strategic planning.

Top management' commitment to IT also signals the importance of IT to employees and shareholders. Users tend to adopt IT more actively when top managers are themselves committed to IT. If the CEO reveals an unfamiliarity with or anxiety about technology, it indicates that the CEO is not supportive, and accordingly, levels of commitment to IT are low (Lederer and Mendelow, 1988). One of the ways in which the top management team can evidence support for IT has been shown to be the number of times IT-related terms are present in the CEO's letters to shareholders, which symbolizes the firm's vision through IT by legitimizing, explaining, and rationalizing the organization's recent investments in IT (Javenpaa and Ives, 1990). This is indicative of the top management team's cognitive and psychological commitments to IT, which motivates the employees to actively pursue IT-related opportunities. If top managers hesitate to actively participate in IT planning, employees tend to resist the adoption of technology (Earl, 1993).

In a study of the relationship between CEOs' vision for IT and firm performance, all five CEOs in the high-performing group aligned themselves with the "vision to transform" (Feeny, Edwards, and Simpson, 1992); in contrast, only one of the nine CEOs in the low performing group made the same choice. The researchers report that a shared vision comes from an excellent relationship between the CEO and the CIO and that when the CEO commits to IT, the CEO-CIO relationship is enhanced, with a shared vision of the role of IT. Conversely, when the CEO is not committed to IT, CIOs are neither direct reports nor members of the top management team, and CIOs' perceptions of critical

issues facing the business rarely match the responses given by their CEOs. Thus, we see that top management's commitment to IT is related to the progressive use of IT (Jarvenpaa and Ives, 1991; Feeny et al., 1992), active adoption of IT (Meador et al., 1984), and user satisfaction with IT (Thong et al., 1996).

In turn, the top management team's commitment to IT impacts firm performance (Jarvenpaa and Ives, 1990; Weill, 1992). Strong top management commitment, as discussed, signals the importance of IT and impacts successful IT implementation. By signaling the importance of the IT to the employees, employees actively seek opportunities to apply IT strategically and operationally. The next section is the importance of IT management capability for successful use of IT.

2.4.2. IT Management Capability

IT management capability involves "(1) better aligning IT products and services with the firm's strategic objectives, (2) delivering solutions faster, and (3) providing high-quality, cost-effective support (Ross, Beath, and Goodhue, 1996, p. 32). Here, it is defined as *IT managers' ability to consistently identify opportunities to apply IT to strategic and operational business needs and implement appropriate solutions.* This definition includes both leadership and knowledge. Identifying opportunities requires IT knowledge, and implementing solutions requires leadership. However, Johnston and Carrico (1988) also see knowledge as a component of leadership, which is "both the vision to see the strategic opportunities for IT and the personal force and persistence to overcome barriers to effective implementation" (Johnston and Carrico, 1988, p. 43). They propose that a CEO who understands the opportunities afforded by IT can serve as

an efficient and strong leader (Johnston and Carrico, 1988). Nonetheless, while knowledge and leadership are related, they are two distinct constructs.

The organizational behavior literature suggests that a transformational leader demonstrates at least three characteristics: creation of a vision, mobilization of commitment to the vision, and institutionalization of change (Tichy and Ulrich, 1984). Visionary leadership sees market needs, communicates the vision to employees, and empowers them to pursue the goal (Westley and Mintzberg, 1989). In the IT literature it is similarly believed that IT leadership should provide clear vision to employees, see the strategic opportunities for IT, and enforce or alter the direction of IT implementation (Orlikowski et al., 1995; Boynton and Zmud, 1987).

Leadership is one of the most important factors in IT implementation success, as shown in Table 2.11 (Johnston and Carrico, 1988; Luftman and Brier, 1999; Lederer and Sethi, 1988). IT leaders provide employees with a vision and translate this vision for them (Roepke et al., 2000). Since the role of the IT manager has changed from simple back-office support to strategic leadership, leadership has become an important construct in IT research (Ross and Feeny, 2000; Roepke et al., 2000). Key challenges for IT leaders are to envision these roles and to develop and implement programs to translate this vision into reality.

IT knowledge held by the top management team enables top managers to identify strategic business opportunities through the use of IT. IT knowledge also allows the top management team to have a shared vision with the CIO, thus fostering strategic alignment (Reich and Benbasat, 2000). It is also important to decision quality in IT governance. A centralized IT governance system takes longer to produce productivity

performance than a decentralized one (Banker et al., 1998). If the top management team doesn't understand the nature of centralized governance and pressures the IT personnel to demonstrate productivity performance, the governance of IT systems in the organization may be suboptimal. Such pressures work against a long-term perspective, discouraging the investments necessary to measure, evaluate, and learn, and to make continuous software process improvements.

The importance of knowledge is also evident in a CASE assimilation study. Since the application is complicated, IT managers need business and technical knowledge to successfully deploy IT, and facilitate the assimilation of the technology within the firm (Fichman and Kemerer, 1999). Knowledge also facilitates the ability to acquire, build, implement, operate, and support IT-enabled business solutions by forecasting short- and long-term needs (Clark et al., 1997).

The senior IT manager's knowledge facilitates a "fit" between business and IT plans (Reich and Benbasat, 2000; Armstrong and Sambamurthy, 1999) and is positively related to firm performance (Jarvenpaa and Ives, 1990; Sabherwal and Kirs, 1994; Bensaou and Venkatraman, 1996; Chan, et al., 1997). Although a strategic fit is a part of IT management capability in Ross et al.'s definition, it seems an outcome of leadership (Luftman and Brier, 1999) and IT knowledge (Reich and Benbasat, 2000). This is therefore addressed separately, in the next section on strategic alignment.

2.4.3. Strategic Alignment

Scholars have explored the relationship between the IT/business strategic alignment and firm performance. Strategic alignment refers to the fit "between a company's actual IS strategy and the theory-based IS strategy corresponding to the

business strategy it pursues" (Sabherwal and Chan, 2001, p. 12). "A key concern of business executives is alignment – applying IT in an appropriate and timely way and in harmony with business strategies, goals, and needs" (Luftman and Brier, 1999, p. 106). Following this definition, it is defined here as *the degree to which a firm's business strategy is aligned with its IT strategy*. Some argue that IT strategy should be aligned with business strategy (Chan and Huff; Sabherwal and Kirs, 1994), while others argue that IT strategy impacts business strategy (Jarvenpaa and Ives, 1990; Porter and Millar, 1985). Whether IT strategy follows or leads business strategy, it depends on a firm's overall IT strategy. This strategic alignment should be derived from the firm's competitive capability, i.e., those distinctive capabilities that enable the firm to conceive of and implement strategies that improve the firm's efficiency and effectiveness (Barney, 1991).

Previous researchers (Hambrick, 1983a, 1983b; Venkatraman, 1989; Child, 1972) argue that strategic alignment enhances firm performance. In the IT arena, following Miles and Snow's (1978) categories of defender, analyzer, and prospector, Sabherwal and Chan (2001) report that alignment between business and IT strategies facilitates performance improvement for Prospectors and Analyzers but not for Defenders. This finding may be because organizations with greater alignment between business strategy and IS strategy are more likely to utilize IT for competitive advantage (Johnston and Carrico, 1988). From matching and moderation models of the alignment perspective, a combination between a highly strategically oriented business strategy and a highly strategically oriented IS strategy represents the highest perceived performance but not the combination between low business strategy and low IT strategy (Chan, Huff, Barclay,

and Copeland, 1997). Another research finding shows that firms that closely match their IT capability to their key success factors are not only more successful in utilizing IT but also perform better (Sa and Hambrick, 1989).

The studies reviewed above provide evidence that strategic alignment is related to firm performance. In order to have strategic alignment, shared knowledge between business and IT managers is important (Reich and Benbasat, 2000). It is particularly important for the top management team to have IT knowledge, because as the impact of IT on organization increases, top management should be able to assess the importance of IT capability and leverage it towards the firm's critical success factors. Similarly, the IT manager requires business knowledge.

2.4.4. Summary of Enterprise-Level IT Management Capability

This section has reviewed work on enterprise-level IT management capability, which is composed of top management team's support, top management capability, and strategic fit. As discussed, top management team's support for IT has been one of the most important success factors in IT implementation because it makes securing funding and motivating employees relatively easy.

Second, top management capability is composed of IT leadership and IT knowledge. An efficient leader is able to mobilize employees to achieve objectives by presenting a vision and communicating with employees. IT knowledge enables top managers to assess the importance of IT implementation and to understand that certain IT investments take longer than any other investments.

The last construct of enterprise-level IT management capability is strategic alignment. Previous research has found that a fit between IT strategies and business

strategies facilitates firm performance. However, these findings may not applicable across all industry types: industries that are heavily relying on IT are more likely to exploit IT opportunities, and these industries are more likely to align IT and business strategies than other industries. The last discussion of literature review is industry strategic IT role.

2.5. Industry Strategic IT Role

Different industries vary substantially in the level of intensity of the integration of technology into their strategic management (Chatterjee, Richardson, and Zmud, 2001; Armstrong and Sambamurthy, 1999). As a result, firm performance based on levels of technology implementation differs across industries (Im et al., 2001; Jarvenpaa and Ives, 1990). Three industry strategic IT roles have been described: automate, informate up/down, and transformational (Chatterjee, Richardson, and Zmud, 2001). Automate use represents replacing human labor with automated business processes. This usually occurs in the manufacturing industry. Informate up/down use indicates providing data/information to empower management and employees, and usually appear in retail and diversified industries. Transformational use refers to the use of technology to fundamentally alter traditional ways of doing business by redefining business processes and relationships (Chatterjee et al, 2001).

Based on a similar categorization of industry types, Johnston and Carrico (1988) investigated eleven industries in three categories: traditional (office equipment and oil companies), evolving (industrial products, food products), and integrated financial industries (services, pharmaceutical distributors, and airline). They report that IT is not used strategically in the traditional industry category, but rather is primarily used for

improving administrative and managerial information systems such as accounting and decision support. IT is used strategically in the evolving industry category, but is not integrated. Integrated companies use IT capabilities strategically in order to create new products and services, to alter linkages with suppliers and customers, and to change their work.

As noted, different industry types have different levels of technological opportunities and, as a result, different speeds of innovation (Ali, Kalwani, and Kovenock, 1993). Some industries have more opportunities to introduce frequent new products (Ali, Kalwani, and Kovenock, 1993; Kotabe and Swan, 1995; Schoonhoven, Eisenhardt, and Lyman, 1990). Abundant technological opportunities might facilitate companies to develop a large number of new products. Industries vary in the payoff from speedy technology commercialization (Ali et al., 1993), the extent of frequency of radical new products (Kotabe and Swan, 1995), and technology commercialization speed (Schoonhoven et al., 1990). The products of high technology industries change rapidly and require rapid new product introductions. Industry effects are positively related to the number of innovative new product and the number of patents (Zahra and Nielsen, 2002).

Different strategic roles of IT appear salient in an event study tracing abnormal stock market returns to newly created CIO positions (Chatterjee et al., 2001). A newly created CIO position announcement made by firms with a transformative strategic IT role exhibited positive returns on stock prices; however, no such affect was seen for firms in non-transformative industries (Chatterjee et al., 2001). Since transformational industries rely on IT more than do other industry categories, CIOs are more likely to be recognized as key organizational members and as vital to the firm's competitive success (Armstrong

and Sambamurthy, 1999). Recent research also reports that firms in the transforming industry category were found to enjoy higher abnormal returns. The authors further report that, among firms in the category of transforming industry, those firms that invested in transforming IT strategic roles enjoyed higher abnormal returns than those firms that invested in other IT strategic roles such as automate or informate up/down.

Further support for the importance of industry strategic IT role is seen in Jarvenpaa and Ives' (1990) study of the frequency with which IT-related words appear in CEOs' letter to shareholders. Here, they found that only one of 22 firms mentioned IT in its 1982 – 1987 annual reports in the petroleum industry (an 'automate' industry). In contrast, over 60% of the companies in retailing, banking, and publishing ('transformative' industries) discussed IT in their annual reports.

2.5.1. Summary of Industry Strategic IT Roles

This section has reviewed industry strategic IT roles. Different industries exploit IT opportunities differently: some industries such as transformative industries integrate IT extensively into their strategies and operations, while other industries are less likely to use IT strategically. Depending on IT opportunities given to different industry types, firm performance also varies, and accordingly, IT expenditure is different across industries.

2.6. Summary of Literature Review

This literature review section included four subsections: firm performance and IT investments, firm performance and complementarity investments, enterprise-level IT management capability, and industry strategic IT roles. The firm performance and IT investments section identified problems with previous research, i.e., modeling problem,

and important constructs, i.e., industry effects and manager's capability. This section provides a basis for construct identifications and allows one to observe problems with the existing IT productivity studies. Among these problems, the concept of complementarity is the major problem identified in this section.

The next section provided a comprehensive review of the concept of complementarity starting from the original work of the concept. In this section, in addition to the original notion of the concept of complementarity, additional constructs, i.e., human capital and incentive systems, are identified.

The following section explicated industry strategic IT roles. This element consistently appears as an important construct for firm performance in the firm performance and IT investment section. Industry strategic IT roles are specified into three categories in the section: transform, informate up/down, and automate. The transforming industry is likely to exploit highest returns from IT investments.

The last section focused on enterprise-level IT management capability that is comprised of top management's commitment to IT, IT management capability, and strategic alignment. This section identified top management commitment to IT as one of the most important factors for successful IT implementation. IT management capability, which has a quality of leadership and IT knowledge, has been found to impact IT use and assimilation. It seems that employees are likely to actively adopt IT when the top manager exercises a strong leadership and possess IT knowledge. IT knowledge of a leader facilitates deploying IT capabilities. The next section deals with theoretical lenses of complementarity.

CHAPTER III: A KNOWLEDGE-BASED VIEW OF COMPLEMENTARITY

The knowledge-based view (KBV) sees that "organizational capability is the integration of individuals' specialized knowledge" (Grant, 1996, p. 375) and considers how these knowledge assets are configured and deployed (Teece, 1998). In these regards, the KBV speaks to two aspects of capabilities: *aggregation of knowledge into capabilities* and the *deployment of knowledge assets in the form of capabilities.*

First, the KBV recognizes organizational capabilities accrue from the aggregation of individuals' knowledge. Such aggregation depends on *human capital* – individuals' specialized knowledge – and *how the human capital is aggregated*. Knowledge may be aggregated in three ways: through organizationally-initiated routinized rules and procedures (e.g., Cohen, 1991), through organizationally-initiated relationship networks (e.g., Uzzi, 1997; Dyer and Singh, 1998), and through naturally-emerging communities-of-practice (e.g., Brown and Duguid, 1991). These three methods or aggregation refer to *structural capital*, *social capital*, and *community capital*, respectively. The combination of these three forms of capital, together with human capital, constitutes organizational capabilities.

Once constituted, the complementary deployment of capabilities is viewed as important by KBV scholars (Hamel and Prahalad, 1993). How these capabilities are deployed shapes competitive outcomes (Teece, 1998). We identify three ways in which organizational capabilities may be deployed in support of a focal investment: as foundational capabilities, synergistic capabilities, or management capabilities. *Foundational capability* is the collection of knowledge assets that must already be in place in order to yield the value from a focal investment. *Synergistic capability* refers to

knowledge assets that amplify the value of a focal investment through the concurrent, value-adding mobilization of assets. *Management capability* deals with the knowledge assets possessed by managers that enable them to identify, invest in and implement a portfolio of capabilities based on an organizing vision. We argue that all these capabilities complement each other and must be present in order to maximize the value to be obtained from the focal investment.

This section is composed of two parts. In the first part, we start with a discussion of foundational, synergistic, and management investment-related capabilities from a complementarity perspective. We then discuss organizational aggregation of individuals' specialized knowledge, i.e., human capital, into investment-specific capability via structural, social, and community capital. These four forms of capital are considered in the contexts of investments in SCM and CRM. We then examine how investment-specific and investment-related capabilities have been considered in the IT and organizational literatures.

Table 3.1: Dimensions and Definitions of Complementarity

Dimension		Definition
Investment-Related Capabilities (knowledge deployment)	Foundational Capability	Capabilities whose existence is necessary, in a path-dependent sense, in order for the base functionality of investment-specific capabilities to be realized
	Synergistic Capability	Investments that are made independent of the focal IT investments, but, when present, mobilize value from the focal IT investment
	IT Management Capability	Managers' capabilities to exhibit an organizing vision regarding the application of IT enabling the identification of opportunities to apply IT to strategic and operational business needs and to implement appropriate, complete solutions.
Investment-Specific Capabilities (knowledge aggregation)	Artifactual Capital (Focal Investment)	Investments that are made in order to solve business problems
	Structural Capital	Organizationally-initiated knowledge accumulation and transfer rules and procedures that coordinate and mobilize the value from the focal investment
	Social Capital	Organizationally-facilitated mechanisms that facilitate access to and the integration of external knowledge and capabilities relevant to the focal IT investment

Dimension		Definition
	Community Capital	Emergent relations within a communities-of-practice that provide access to knowledge and capabilities in mobilizing value from the focal IT investment
	Human Capital	Individuals' specialized skills and knowledge that contribute to the mobilizing of value from the focal IT investment

3.1. Investment-Related Capabilities

Investment-related capabilities are those that have previously been constituted or are concurrently being constituted towards other purposes, and thus are not specific to the focal investment; yet, their presence contributes to returns on the focal investment. From the KBV perspective, a firm's ability to coordinate and deploy investment-related capabilities in ways that multiply the value of the focal investment creates competitive advantages (Hamel and Prahalad, 1993). As noted earlier, these investments are considered in terms of foundational, synergistic, and management capabilities. These capabilities are now considered in detail.

3.1.1. Foundational Capabilities

Foundational capabilities must already be coalesced and in place in order for the value of the investment-specific capabilities to be realized. Foundational capabilities, thus, can be defined as *capabilities whose existence is necessary, in a path-dependent sense, in order for the base functionality of investment-specific capabilities to be realized*. An important IT-based foundational capability is the existence of an appropriate IT infrastructure (Zhu and Kraemer, 2002). Organizational foundational capabilities include the capabilities for generating new organizational forms through the recombination of resources and structures (Ciborra, 1996) and generating operational processes that can create, produce, and deliver products and services according to customers' changing needs (Garvin, 1995). They also include firm capabilities for integrating across

functional areas following innovation (Teece, 1986). Without such foundational capabilities, economic value from IT investments will not be realized.

3.1.2. Synergistic Capabilities

Synergistic capabilities, constituted by firms' investments in inputs not directly pertinent to the focal investment, augment the realized value of investment-related capabilities. Synergistic capabilities are defined as *those investments that are made independent of the focal IT investments, but, when present, mobilize value from the focal IT investment.* Organizations continuously select some resources and capabilities over others in order to enhance firm performance (Nelson and Winter, 1982). These selected resources and capabilities can further enhance firm performance if they have synergies with each other (Hamel and Prahalad, 1993). Investments in synergistic capabilities are not directly oriented toward the focal investment; rather these capabilities serve some other purpose. Therefore, these capabilities are not required as is the case for foundational capabilities, but they amplify the value of the focal investment.

Little attention has been given to synergistic capabilities across the IT and organizational literatures. While Milgrom and Roberts (1990) recognized investment-specific complementarities (e.g., inventory management), they claimed that, when CAD and CAM implemented together, firms could introduce new products more frequently and can lower product prices. Since these two investments are designed for different purposes, each investment yields value without the presence of the other, but when present together, their individual contributions to firm performance are enhanced.

The synergistic effects of SCM, CRM, and NPD, which are all designed for different purposes, are discussed by Srivastava et al. (1999). SCM facilitates the

selections of qualifying suppliers and materials, while CRM informs potential new customers and helps the determinations of the qualities and quantities of materials to SCM. NPD produces new products based on the information from CRM. Therefore, when these three investments exist together, they increase the effects of each investment.

3.1.3. Management Capabilities

Management capabilities are defined as senior *managers' capabilities to exhibit an organizing vision regarding the application of IT enabling the identification of opportunities to apply IT to strategic and operational business needs and to implement appropriate, complete solutions*. Organizing vision refers to knowledge assets possessed by top managers that require three elements: interpretation, legitimation, and mobilization (Ramiller and Swanson, 2003). Interpretation refers to managers' knowledge regarding a focal investment. Legitimation deals with encapsulating the focal investment, i.e., building a business case, richly within the business context. Mobilization refers to the manner in which organizational resources are deployed (Moran and Ghoshal, 1999). Based on this vision, managers may diminish or augment foundational capabilities and deploy capabilities synergistically or in a piecemeal fashion.

3.2. Investment-Specific Capabilities

Investment-specific capabilities are defined as *complementary investments that ensure the focal investment will be infused within organizational and individual work behaviors and practices such that the full potential of the focal investment might be realized*. Essentially, the constitution of investment-specific capabilities enables the knowledge assets held by individuals (*human capital*) regarding the focal investment to be shaped into organizational competence (Teece, 1998) through organizationally-

initiated routines, rules and procedures (*structural capital*) (e.g., Cohen, 1991; Cohen and Bacdayan, 1994), relationships (*social capital*) (e.g, Uzzi, 1997; Hansen, 1999), and emergent communities (*community capital*) (Lave and Wenger, 1991; Brown and Duguid, 1991, 2001). Since individuals' knowledge accumulates through these three mechanisms, organizations must strive to facilitate each in order to fully exploit individually-held knowledge assets. Thus, four forms of human, structural, social, and community capital complement each other and collectively amplify the value of a focal IT investment, henceforth termed *artifactual capital*.

3.2.1.1. Artifactual Capital

Artifactual capital is defined as *those investments brought to bear on a specific business problem or opportunity*. For example, SCM investments are targeted at improving internal and external efficiencies associated with a firms extended relationships with suppliers. In addition to making SCM-specific investments, in order to more fully appropriate the potential value from SCM systems, investments in associated structural, social, community and human capitals should also occur.

3.2.1.2. Structural Capital

Structural capital has been described as knowledge that "doesn't go home at night … [but it] belongs to the organization as a whole" (Stewart, 1998, pp. 108, 109). Organizations develop rules and procedures that can coordinate individual specialists with different knowledge (Grant, 1996). Here, structural capital is defined as *organizationally-initiated knowledge accumulation and transfer rules and procedures that coordinate and mobilize the value from the focal investment.* These rules and procedures store recurrent operating activities that can be used to direct or guide work

practices (Cohen, 1991; Cohen and Bacdayan, 1994; Winter and Nelson, 1982). Firms rely upon these routinized behaviors because they are efficient ways of doing things that are well understood.

3.2.1.3. Social Capital

Social capital is defined as *organizationally-facilitated mechanisms that facilitate access to and the integration of external knowledge and capabilities relevant to the focal IT investment*. Such social capital engenders mutual trust, a shared identity, and social norms (Nahapiet and Ghoshal, 1996). Social capital thus serves as a means for exchanging knowledge and capabilities not otherwise available (Granovetter, 1985, Coleman, 1988).

3.2.1.4. Community Capital

Because of their implications for organizational design and management, we distinguish the construct of social capital from that of community capital. Whereas social capital is conceptualized as being organizationally-facilitated (e.g., Hansen, 1999), *community capital* is viewed as emergent in organizations' communities-of-practice, which are constituted during work-related interactions (e.g., Brown and Duguid, 1991). Communities-of-practice cannot be managed; in fact, efforts to manage them can destroy them (Stewart. 1999). Yet, organizationally-initiated rules and procedures often do not capture how employees interact or the way knowledge flows among individuals; emergent communities provide an alternate pathway for employee learning and innovation (Brown and Duguid, 1991). Thus, community capital is defined as *emergent relationships within communities that provide access to knowledge and capabilities in mobilizing value from the focal IT investment*. It arises because practice creates

"epistemic differences among communities within a firm, and the firm's advantage over the market lies in dynamically coordinating the knowledge produced by these communities" (Brown and Duguid, 2001, p. 198). Learning, in this perspective, is viewed as situated activity (Lave and Wenger, 1991).

Learning through communities-of-practice occurs through a dynamic process of interacting with others in one's field rather than from standard instructional manuals or guidelines. This type of learning assists community members in dealing with the unanticipated problems that often arise. The knowledge attained in addressing these practical problems often leads to innovations (Brown and Duguid, 1991). Useful knowledge in organizations is often best developed by the members of a community of practice in which the problem to be solved arises (Brown and Duguid, 2001). While organizations cannot directly control knowledge transfer via this mechanism, community norms and obligations govern knowledge transfer (Stewart, 1999).

3.2.1.5. Human Capital

Human capital theorists argue that firms invest in human resources in order to enhance economic returns (e.g., Becker, 1962). The importance of human capital was first highlighted by Becker, who proposed that it influenced "future real income through the imbedding of resources in people" (Becker, 1962, p. 9). Becker (1993, p. 15) sees human capital, like any other tangible capitals, as yielding "income and other useful outputs over long periods of time." Human capital is defined here as *individuals' specialized skills and knowledge that contribute to the mobilizing of value from the focal IT investment.* As with any other form of capital, investment in human capital is justified when employees' training and education yields an increase in future productivity

(Becker, 1964; Lepak and Snell, 1999). Human capital has been recognized as an important factor in complementarity discussions (Adler, 1988; Snell and Dean, 1992; Barua et al., 1996; Hitt and Brynjolfsson, 1997; Powell and Dent-Micallef, 1997), and has been reported significant (Hitt and Brynjofsson, 1997).

3.2.2. Investment-Specificity of Forms of Capital: SCM and CRM Contexts

Since IT investments are designed to achieve specific business objectives, the nature of human, structural, social, and community capitals that constitute IT-based capabilities within distinct investment contexts are expected to differ. The focal IT investments to be examined in this dissertation are SCM and CRM. Firms invest in SCM in order to improve internal and external efficiency. The objective of CRM is to enhance customer satisfaction and hence increase market share and revenue. Illustrations of the different forms of capital within the SCM and CRM contexts are now provided.

Structural Capital

Organizations develop rules and procedures to derive value from focal investments. Since organizations deploy SCM and CRM to solve different business problems, SCM and CRM require different rules and procedures in order for the technological investments to yield value. However, decentralized decision-making is important in both SCM and CRM since these technologies are oriented toward managing decision environments that are increasingly turbulent and complex and require more frequent and faster decision-making (Huber, 1984; Huber and McDaniel, 1986). In order to successfully exploit the new capabilities provided by SCM and CRM, firms need to push decisions appropriately out to front-line workers and their managers.

Social Capital

SCM- and CRM-deploying firms may engernder social capital with other firms (e.g., suppliers and vendors) or with customers. These organizationally-initiated networks often facilitate the development of social capital that helps information and knowledge flows. Such networks and capital in turn may complement value of SCM and CRM. For example, vendor managed inventory (VMI) and collaborative forecasting, planning, and replenishment (CFPR) are a good way to connect firms. However, value extraction from such technology-enabled networks requires trust in order for firms to reveal sensitive information (Hart and Saunders, 1997) and to transfer quality information (Petersen et al., 2005). In the case of CRM, firms may initiate technology-enabled networks between employees and customers in order to discover customers' responses to, or potential problems with, new products (Nambisan, 2002; Yli-Renko, 2001). Organizationally-initiated relationships often serve as knowledge acquisition channels for products, which in turn leads to improved firm performance (Yli-Renko, 2001). Therefore, such organizationally-initiated social capital complements the value of SCM and CRM.

Community Capital

Community capital is viewed as knowledge assets that naturally emerge through work-related interactions. Unlike other forms of capital, this capital is not purposely designed or invested in by organizations, but important work-related knowledge flows through this relationships. Community capital is important as the use of technology becomes context-specific. Both SCM and CRM require data standardization in order

extract value from the investments. Since data standardization connects peoples across different divisions, it enables employees to work and solve problems together and supports cross-functional community capital (Cross et al., 2001). Communities-of-practice are especially valuable because rules and procedures may not be able to guide all operational processes especially when environments change rapidly, which is the case in environments in which SCM and CRM investments are typically made. In such environments, voluntary information sharing facilitates coordinated activity (Brown and Duguid, 2001). Therefore, information sharing is a critical aspect of community capital with regard to both SCM and CRM.

Human Capital

Human capital has been extensively discussed among complementarity scholars in IT. Although scholars did not distinguish between investment-specific human and investment-related IT human capital, these studies generally reported a significant relationship between human capital and IT performance.

The main objective of SCM is to connect internal and external value chains. Accordingly, economic value from human capital is likely to be derived from the users' capability to manage specific skills such as logistics, vendor management, and data analytical skills. Therefore, SCM-deploying firms are likely to train their employees in these skills. It is especially critical for call center agents as these employees interact directly with the customer and are the key to bigger profits for consumer product and service companies (Schafter, 2001). Since CRM providers upgrade functionalities frequently, sales associates are under increasing pressure to be technologically savvy and to resolve customer problems rapidly (Schafter, 2001). In order to effectively access

customer and product information through complicated functionalities, users need to be adequately trained.

3.3. Summary of a Knowledge-Based View of Complementarity

This section includes the discussions of two aspects of complementary investments from the KBV perspective. First, we identify four complementarities directly linked with investments in artifactual capital: human, social, community and structural capitals. Second, three additional complementary capabilities were also identified to further mobilize the value potential of artifactual capital: foundational, synergistic, and management capabilities. The next chapter introduces the study's research model and develops specific research hypotheses.

CHAPTER IV: RESEARCH MODEL AND HYPOTHESES

This section develops the study's research model and hypotheses. The arguments offered highlight the manner in which each constituent capability complements a focal IT investment, i.e., artifactual capital.

4.1. The Nature of Complementarity in IT Investments

This study extends the model proposed by Tanriverdi and Ruefli (2004) by articulating the different roles of complementary investments. Human, structural, social, and community capitals are modeled as aggregating into *investment-specific capabilities*. Consistent with Tanriverdi and Ruefli, the effects of these inputs are viewed as additive. Additionally, *foundational capabilities* must be in place in order for the value of the investment-specific capabilities to be realized. *Synergistic capabilities*, representing the coalescence of investments in inputs that are not directly relevant to the focal investment, serve to amplify the value of the focal investment. *Management capabilities* leverage the value of investment-specific investments by ensuring both that appropriate complementary investments accompany the focal investment and that all investment initiatives are implemented in an effecting manner. This perspective is summarized in the conceptual model provided in Figure 4.1.

Figure 4.1: Conceptual Model and Roles of Complementarities

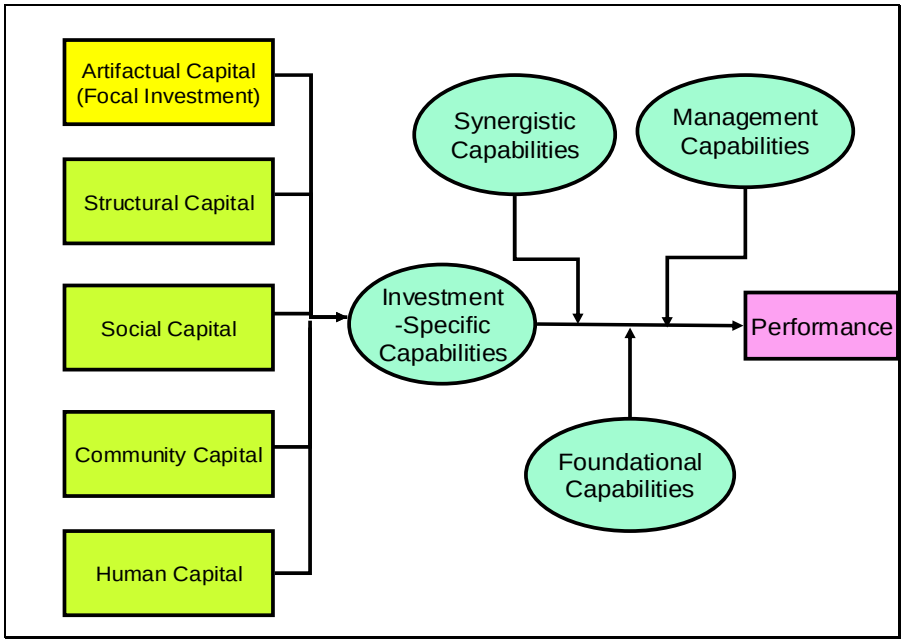
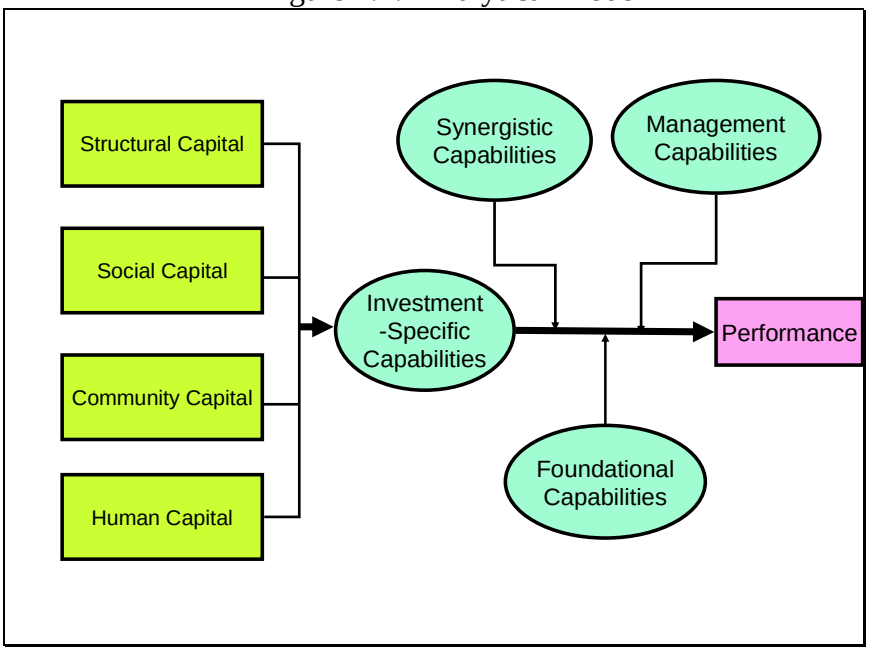


Figure 4.2: Analytical Model



As shown in Figure 4.1, investment-specific capabilities include five types of capital: artifactual, structural, community, social, and human capital. In the analytical

model depicted in Figure 4.2, since only those firms that deployed SCM/CRM will be considered, hypothesis development for the impacts of artifactual capital will not be offered. Consistent with previous literature on IT investments, the hypotheses of the investment-specific capabilities are proposed to directly affect firm performance. Since the roles of investment-related capabilities enable or amplify returns from the investment-specific capability, investment-related capabilities are proposed to moderate these direct relationships.

4.2. Investment-Specific Capabilities

A focal investment (or artifactual capital) is designed to solve business problems. Four forms of capital are identified here as complementing the focal investment or artifactual capital. Consistent with previous literature, these four forms of capital are hypothesized as having direct effects on firm performance.

4.2.1. Structural Capital

As noted earlier, structural capital refers to organizationally-initiated routines, rules and procedures that aggregate individuals' knowledge. Previous literature has considered structural capital in terms of modular forms (e.g., Sanchez, 1999) and decentralized decision-making (e.g., Huber and McDanniel, 1986) that facilitate the aggregation of individual knowledge. A modular form reduces information overload and development and maintenance costs, while it allows the flexibility and knowledge accumulation that can lead to innovation (Worren et al., 2002; Sanchez and Mahoney, 1996; Woolsey, 1994). Therefore, scholars have consistently noted a significant effect of a modular product architecture on firm performance (e.g., Worren et al., 2002; Kekre and Srinivasan, 1990). Managers in U.S. and U.K home appliance companies reported a

positive relationship between modular product architecture and firm performance, which is measured by model variety (i.e., the number of product models offered by the firm) and higher levels of model variety. Also, model variety was found to be significantly influenced by modularity (Kekre and Srinivasan, 1990).

As with modular form, decentralized decision-making also enables each division to accumulate knowledge and respond to fast changing environments. Such organizational design is especially beneficial to deployment of technologies such as SCM (Fan et al., 1999). Fast decision-making has been found to enhance performance in turbulent environments (Eisenhardt, 1989). Therefore, H1 is developed as follows,

H1: Investments in salient structural capital will increment the performance of firms that have invested in the focal IT

4.2.2. Social Capital

Studies on social capital suggest that it facilitates access to information and knowledge, thereby enhancing firm performance (Hansen, 1999; Ahuja, 2000; Stuart, 1998; Uzzi, 1996). Social capital also fosters trust and a shared understanding, which, in turn, facilitate individuals' sharing of information and complex knowledge (Granovetter, 1983; Nahapiet and Ghoshal, 1998).

Social capital is also observed between service representatives and the customers in entrepreneurial high-technology ventures (Yli-Renko et al., 2001). This study examined the effects of relationships with key customers on knowledge acquisition using a sample of 180. The study found that social interactions with customers were positively related to knowledge acquisition, and in turn the knowledge positively contributed to firm performance – as measured by new product development, technological distinctiveness,

and sales cost efficiency (Yli-Renko et al., 2001). Therefore, one can expect the benefits of social capital as follows,

> *H2: Investments in salient social capital will increment the performance of firms that have invested in the focal IT*

4.2.3. Community Capital

This concept has not been considered before in terms of complementarities associated with IT investments. However, economic benefits of emerging nature of community capital have been observed in many areas - in relationships among employees at executive levels, between users and IT planners, and among employees.

Research on executive-level interactions reported the benefits from emergent interactions (Armstrong and Sambamurthy, 1999; Feeny and Wilcocks, 1998; Watson, 1990). Frequent face-to-face relationships between the CIO and the CEO contribute to a shared understanding about strategic role of IT within the business context. Interactions among users also facilitate efficient communications, which in turn leads to a successful system implementation (Watson, 1990), and positive effects of the project outcomes (Watson and Haley, 1998).

The benefits of interactions via shared understanding are also examined in an IT investment study, especially at the IT planning stage. The interactions among the group of planners contributed to the shared language and the vision that lead to information and knowledge transfer (Kydd, 1989; Watson, 1990). At the planning stage, since the developer and the users commonly don't have a shared understanding of an issue, close interactions are most important here in order for the project to be successful.

Employee interactions also enhance success of IT implementation. For example, the movement of IT professionals from the IT domain to business areas has been

observed to mobilize an active relationship within the firm to both identify IT-enabled business initiatives and facilitate their implementation (Reich and Kaarst-Brown, 1999). Therefore interactions among employees complement a focal IT implementation, especially given that employees in an organization are more likely to get information from their personal contacts than other types of sources, such as the Internet (Cross et al., 2001).

However, emergent relationships are a double edged-sword; depending on the nature of interactions, relationships can have a positive or negative effect on organizational performance. Advice networks, defined as "relations through which individuals share resources such as information, assistance, and guidance" (Sparrowe et al., 2001, p. 317) have a positive effect on individual performance, though not on group performance. On the other hand, the hindrance networks, described as interference, threats, sabotage, and rejection, are significantly and negatively related to both individual and group performance (Sparrowe et al., 2001). Although this research reported evidence of positive and negative effects of relationships, overall, these studies reported that relationships facilitate knowledge transfer. As a consequence, firms whose employees participate in internal and external interactions are expected to outperform firms, and therefore H3 is as follows:

H3: Investments mobilizing salient community capital will increment the performance of firms that have invested in the focal IT

4.2.4. Human Capital

This construct has long been recognized in complementarity literature, which has reported positive impacts on firm performance. Training, one of the important facets of human capital, gains most attention because of the rapidly-developing and complex

nature of IT. Training improves users' computer skills, which are found to be positively related to the utilization of an IT in the decision-making process (Nelson and Cheney, 1987). A similar study using 378 DSS users from 124 organizations reported also a positive relationship between length of user training and the improved decision making, and between training and the users' satisfaction (Sanders and Courtney, 1985). Although Nelson's and Cheney's study did not measure firm performance directly, there were studies that supported the positive relationship between an extensive use of the computer by employees and firm performance (Devaraj and Kohli, 2003; Sanders and Courtney, 1985).

Staffing has been an important issue in the IT arena (Roepke et al., 2000), and it has a positive impact on firm performance (Snell and Dean, 1992; Youndt et al., 1996). Staffing is a good avenue to reduce future training costs because competent users require less training (Snell and Dean, 1992).

Therefore, it is not surprising that managers [SIM members] have identified technological human capital as one of the most important managerial issues (Brancheau et al., 1996). The respondents argue that shortages of qualified IT personnel threaten many organizational abilities to make effective exploitation of IT opportunities. For this reason organizations provide IT training in the job place, which improve users' capability to use the computer resource (Nelson and Cheney, 1987).

The positive impacts of human capital on firm performance is also evident in business literature (e.g., Delery and Doty, 1996; Huselid and Becker, 1996; Huselid et al., 1997; Snell and Dean, 1992; Erickson and Jacoby, 2003). However, another study based on 405 publicly trading firms drawn from COMPUSTAT shows a negative relationship

between an intensity of training and firm performance measured by Tobin's *q* and cumulative shareholder returns (Molina and Ortega, 2003). The authors provide plausible explanations that "responses to the survey were given during a period of financial difficulty, as reflected in the tendency to reduce training budgets as a relatively easy way to cut expenses in periods of slack demand. Another possible explanation is that while firms offer more training, they may be doing so in an inadequate manner either because they train in the wrong arena such as fields that are not directly related to the employee's job." It could be a staffing problem that the firms may have been neglected. Low-ability employees consume more time and firms resources than high-ability employees, which in turn drain firms' resources (Snell and Dean, 1992). Therefore, one can draw conclusions that human capital has a strong impact on firm performance, and accordingly, H4 is,

H4: Investments mobilizing salient human capital will increment the performance of firms that have invested in the focal IT

4.3. Investment-Related Capabilities

Investment-related capabilities, as discussed, are not directly toward a specific investment, but provide value to the focal investment. These involve a firm's capabilities that enable value extraction from other application-level investments. Three capabilities were identified earlier - foundational, synergistic, and management capabilities.

4.3.1. Foundational Capabilities

Foundational capabilities refer to capabilities that enable or, through their absence, constrain value extraction from investment-specific capital. Such capabilities include the availability of an appropriate business and technological (Davern and Kauffman, 2000) infrastructures. For example, if a firm's strategy is to yield value from

e-commerce, the firm may need to invest in e-commerce infrastructure to enable the strategy. An empirical study supported that those firms in the high-IT intensity environments were likely to enjoy high performance from e-commerce strategy enabled by the infrastructure (Zhu and Kraemer, 2002). Since such capabilities are required in order to extract value from investment-specific capital, adequate investment in such capabilities will enable expected returns from a focal IT investment. Therefore,

H5: Investments in foundational capabilities will moderate the payoff from investment-specific capital

4.3.2. Synergistic Capabilities

Literature on synergistic capabilities is sparse although it has surfaced as important. Identifying and deploying investments that can synergize a focal investment provide value (Milgrom and Roberts, 1990). As discussed, CAD and CAM together enable firms to introduce new products frequently while lowering production costs. Also, SCM and CRM enable each other's benefits via information sharing. Therefore, one can expect H6 as follows,

H6: Investments in synergistic complementary investments will moderate the payoff from investment-specific capital.

4.3.3. IT Management Capabilities

IT management capability refers to top managers' organizing vision to consistently identify opportunities to apply IT to strategic and operational business needs and to implement appropriate solutions. IT management capability includes IT manager's IT knowledge, business knowledge, and IT leadership skills. Among them, IT leadership skills also have been subject to numerous studies and found to be highly correlated with successful IT implementation (Johnston and Carrico, 1988; Luftman and

Brier, 1999; Lederer and Sethi, 1988). Successful leaders provide strategic vision (Westley and Mintzberg, 1989) that serves to redirect the use of technology (Orlikowski et al., 1995). For these reasons, scholars above have found positive relationship between IT management capability and IT implementation or plan, therefore, H7 is,

H7: The presence of superior management capability will moderate the payoff from investment-specific capital.

4.4. Control Variables

Previous literature identifies two variables that are related to firm performance: industry strategic IT roles and firm size. Some firms outperform their counterparts just because they have more resources or they are in an industry that is more likely to benefit from the development of advanced technology.

4.4.1. Industry Strategic IT Roles

As discussed earlier, three types of industry strategic IT roles exist: automate, informate up/down, and transformate. Prior research has shown that the economic benefits that accrue from strategic IT roles are different (Dehning, Richardson, and Zmud, 2003; Im et al., 2001; Jarvenpaa and Ives, 1990). Companies in the transforming industry category use IT to fundamentally "redefine business and industry processes and relationships" (Dehning et al., 2003, p. 639). Since these firms disrupt their organizational processes via innovative IT-enabled business models, the benefits accruing from the IT-enabled transformation are very likely to depend on their complementary changes across the organization (Moorman and Slotegraaf, 1999).

4.4.2. Size of Firm

Most likely attributable to the available of greater resources, firm size is expected to moderate the relationship between the use of the technology and performance (Swamidass and Suresh, 1998).

4.5. Summary of Research Model and Hypotheses

This chapter included the proposed research model and offered the development of hypotheses based on previous literatures. The hypotheses were grouped into investment-specific and investment-related capabilities. Four forms of capital: structural, social, community, and human constitute investment-specific capability, and they are proposed here to directly affect firm performance. Since investment-related capabilities enable or synergize the investment-specific capabilities, they are proposed as moderating variables. The next chapter provides the operationalization of the study's constructs within the SCM and CRM contexts.

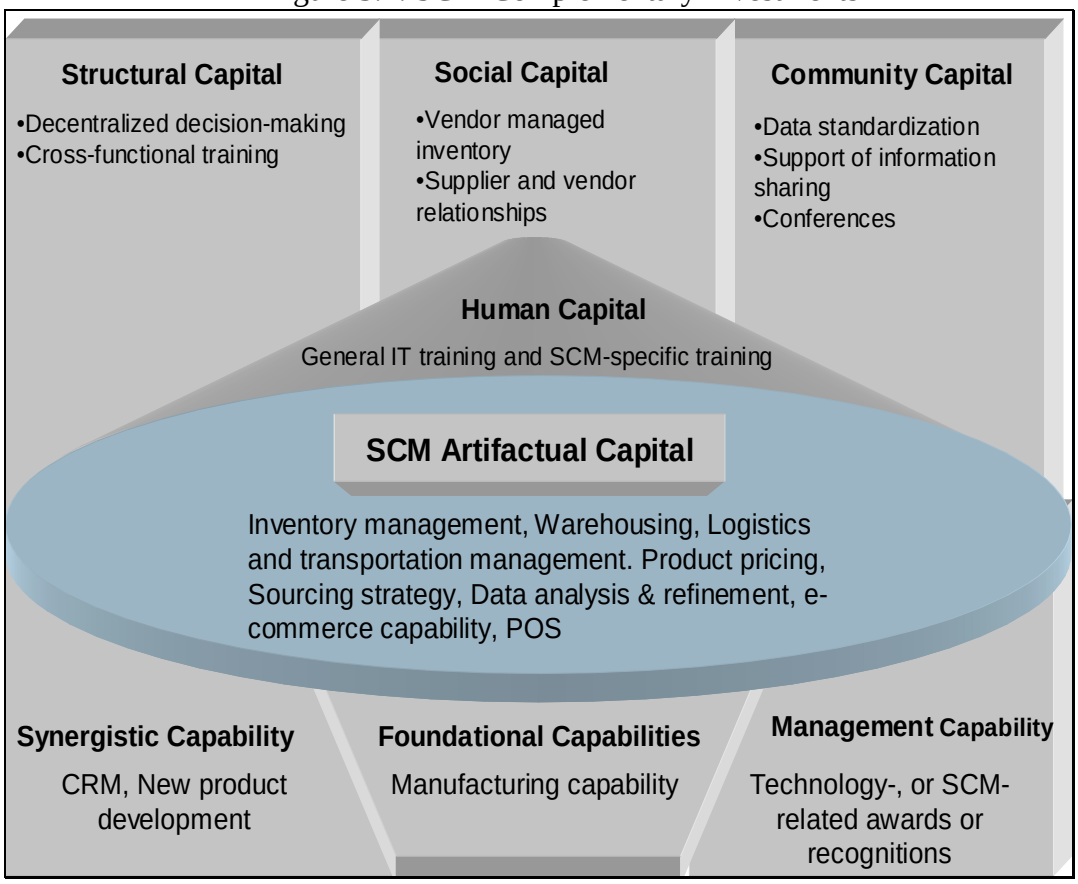
CHAPTER V. OPERATIONALIZATION OF COMPLEMENTARITY

This chapter discusses the operationalizations of the complementarity constructs with respect to SCM and CRM. As with previous chapter, the organization of this chapter is grouped into investment-related and investment-specific capabilities related to SCM and CRM.

5.1. Focal Investment Context: SCM

SCM refers to "networks of companies that work together and coordinate their actions to deliver a product to market" (Hugos, 2003, p. 4). It involves identifying qualified potential vendors, managing resource acquisition, and orchestrating outbound and inbound logistics (Srivastava et al., 1999). The purpose of SCM investments is to improve internal and external efficiency and responsiveness through the elimination of waste and better use of internal and external supplier capabilities and technology (Morgan and Monczka, 1996). Although SCM alone has the potential to significantly increase internal and external efficiency, complementary investments are expected to augment value of SCM. Figure 5.1 shows the complementary investments in SCM.

Figure 5.1: SCM Complementary Investments



SCM artifactual capital is composed of SCM component functionalities. Although these functionalities are continuously evolving, these functionalities in presented Figure 5.1 are commonly available across SCM software. As discussed, while the four forms of structural, social, community, and human capital are specifically invested in order to enhance the value of SCM, the three investment-related forms of foundational, synergistic, and management capabilities enhance value from organizational investments including SCM. The operationalizations of these constructs are offered in the order of investment-related and investment-specific capabilities.

5.1.1. Investment-Related Capabilities

This section considers the operationalization of foundational, synergistic, and management capabilities in the context of SCM investments.

5.1.1.1. Foundational Capabilities

Foundational capabilities are required to mobilize the value from SCM implementation. Manufacturing is proposed here to be a foundational capability. SCM facilitates material purchasing that will be used for production, and helps efficiently deliver those products to end users. Thus, a manufacturing capability lies at the heart of the SCM function (Spekman et al., 1998). Manufacturing capability is measured by ***demand forecast and production capabilities***.

Demand forecast capability is a required SCM function that enables firms to plan their manufacturing for products and goods based on their demand forecasting. An overly optimistic forecast results in high levels of unused materials, while, a pessimistic forecast may engender product shortages. This capability also enables firms to reduce fixed costs and to increase SCM efficiency (Sodhi, 2003). The constant evaluation of demand forecast is required for firms to make products available.

Production capability depends on the firm's demand forecast. Therefore, firms need to constantly evaluate manufacturing capabilities (Sodhi, 2003) to meet customers' demand. This evaluation is a basis for firms to close or expand parts of their production facilities. Demand forecast capability serves as a basis for improving productivity and lowering costs (Anonymous, *Industrial Engineer*, 2004; Witt, 2005; Anonymous, *CabinetMarket*, 2004). Some firms improve production capabilities in order to produce new products. For example, as The AminoScience laboratories of Ajinomoto Co. Inc.

discovered new medicines, the firm invested in new manufacturing capabilities in order to produce these new products (Hug, 2004). A similar manufacturing investment was observed in Intel when the firm produced smaller and better-performing chips (Anonymous, *CabinetMarket*, 2004).

Firms often improve production capabilities in order to improve product quality. For example, CertainTeed Corp invested in state-of-the-art manufacturing plant when the firm produced ToughGard2, a fiberglass textile that absorbs noise generated by central air handling equipment. This product is acoustically and thermally superior to competitive lines and to its earlier version (Skaer, 2004).

5.1.1.2. Synergistic Capabilities

Synergistic capabilities, as noted, are those capabilities that amplify focal investments. ***New product development (NPD)*** and ***CRM*** have such synergies with SCM investments. An improvement in ***NPD*** facilitates product design, customization of solutions, and adaptation of product use by customers (Srivastava et al., 1999), and thus this capability ensures that SCM delivers products and services that customers want. The measurement is based on the investments in process, software, or hardware that can improve new products and services.

CRM provides first-hand customer information to SCM for purchasing, manufacturing, and delivering products. CRM data produce a basis for demand forecasting, product pricing, and inventory management thereby supporting SCM planning functionality. In fact, CRM data are better able to accurately forecast needs for raw materials (Breskin, 2003). Precision demand forecasting is important to alleviate inventory holding costs and minimizing warehouse usage. By connecting to CRM data,

manufacturers can take advantage of the data to fine-tune factory forecasts and identify the most profitable products and customers (Breskin, 2003). Another example of CRM and SCM complementing each other is a high-margin account that could lose its preferred status if analysis reveals that the customer has costly handling or service requirements. Likewise, custom features or unforgiving delivery deadlines that disrupt production or shipping schedules might diminish the appeal and profitability of a once highly regarded customer. These issues can be best resolved by integrating connecting CRM and SCM.

5.1.1.3. IT Management Capability

The operationalization of this construct is SCM-, or IT-related awards received by the organization. SCM technical awards are given to those firms (or CIOs) that use SCM technology strategically. For example, the Supply Chain Council offers 5 awards. These awards are given to those firms that demonstrated "excellence in the design, operation or improvement of the significant components of the supply chain they operate" (http://www.supply-chain.org/awards.htm), "a methodology or product that enables superior performance in supply chain operations" (http://www.supply-chain.org/awards.htm), or "the greatest contribution to demonstrating or advancing the supply chain management body of knowledge within the last year. (http://www.supply-chain.org/awards.htm).

Technological awards are given to those firms that utilize "state-of-the-art information technology to streamline its operational environment and reduce processing and operating costs" (*Business Wire*, April 12, 1999, Monday) and apply "advanced technologies and solutions to solve critical business issues" (*PR Newswire*, September 2,

2003). Therefore, these awards represent managers' capability to deploy SCM strategically to enhance value to the firm.

5.1.2. The Constitution of the Investment-Specific Capability

Here we consider the nature of structural, social, community, and human capital involved in the constitution of the SCM capability. Operationalization of these constructs is now discussed.

5.1.2.1. Structural Capital

SCM structural capital refers to those routines, rules and procedures that organizations invest in so as to enhance the value of SCM. When a technology is deployed in an organization, firms often change their organizational structure in order to maximize the value of the technology. An efficient organizational structure in relation to SCM is believed to be decentralized decision-making (Fan et al., 2003; Yu et al., 2001) because of the fast and expertise-based decision-making and environmental scanning that such decentralization encourages. These are important to the dynamic environments within which SCM tends to be implemented. ***Decentralized decision-making*** enables each division to respond to its environment rapidly with accumulated knowledge. In SCM, individuals in specialized divisions such as purchasing, manufacturing, or logistics accumulate knowledge in their own areas and understand the environment. Further, point-of-sale and RFID generate huge quantities of data that must be processed in real time in order to deliver value to the firm. In these situations, decentralized decision-making is appropriate in SCM (Yu et al., 2001).

However, in such decentralized organizations, decision authority must be shared among interdependent members. Since decentralized decisions are made based on

expertise within the separate divisions, that are interdependent but may not communicate effectively with each other, functional silos may result. In order for individuals to manage such interdependencies in decision-making, they require some common knowledge (Grant, 1996). Such common knowledge is garnered through cross-functional training. Therefore, structural capital is also operationalized in terms of ***cross-functional training*** in the context of SCM investments.

In the context of SCM, different functional areas perform distinctively different tasks (Hannon, 2004; Lawton, 2004). Independent, decentralized decision-making will result in each functional area optimizing its outcomes, whether it is boosting profitability, speeding time to market, lowering inventory costs, or improving service levels, the longer lead times stall production. However, individually optimal outcomes could aggregate to a negative outcome for the organization. Thus effective deployment of SCM requires a knowledge sharing mechanism with which divisions are interdependent (Hannon, 2004).

Cross-functional training tears down communication barriers and creates relationships across divisions (Koberstein et al., 2002). Cross-functional training improves interactions (Markus et al., 2002) and understanding of the necessity of other divisions' requirements (Duffy, 1997). A pharmaceutical company faced a problem with functional silos between marketing and R&D divisions. The two divisions each dealt with their own environments excellently and made decisions accordingly. However, the marketing division was not aware of what R&D could produce, and the R&D was unaware of the marketing strategy. Therefore, the value from the two divisions at the enterprise level was low. The firm coordinated and helped these two divisions to be familiar with each other's work through cross-team and cross-functional training, which

in turn, led to higher performance. Therefore, cross-functional training provides a working knowledge of what others do (Graves, 1999). For this reason, it is not surprising that teamwork is the skill rated most important for SCM (Gammelgaard and Larson, 2001).

5.1.2.2. Social Capital

In SCM, social capital is considered in terms of vendor managed inventory (VMI) and supplier and vendor relationships (e.g., Holweg et al., 2005; Micheau, 2005). Previous literature shows that successful implementations of VMI and supplier-vendor relationship are based on trust (Faloon, 2000; Jessop, 1999), therefore social capital in SCM is operationalized by ***VMI*** and ***supplier-vendor relationships***.

Vendor managed inventory (VMI) is organizationally-initiated SCM relationships oriented toward minimizing stock-outs and improving sales and customer satisfaction (Schenck and McInerney, 1998). In such relationships, suppliers are empowered to manage inventories of agreed-upon items at retailer locations (Schenck and McInerney, 1998). Since firms share real-time data with their VMI partners, suppliers fill stocks that are low. They are responsible for the stock levels and the risks of stock piling unpopular products or running short of high-demand products are minimized through sharing of customer data. The success of VMI depends on firms' ability to trust their vendors because firms need to make sensitive data available to their vendors and rely on them to efficiently manage their inventories (Faloon, 2000).

Supplier-vendor relationships refer here to partnering relationships in providing inventories. Often firms make an exclusive relationship with a qualified provider. It is vital to develop partnerships with suppliers for a successful SCM strategy (Kumar,

Bragg, Creinin, 2003). Although these relationships are not independent of VMI, it is one step closer to the provider in terms of inventory forecasting and strategic inventory management. For a vendor firm to feel comfortable opening its database and customer analysis for VMI management, a supplier firm must a reliable and trustworthy partner. Further, the vendor firm will likely want to keep a close relationship with the partner. Within this relationship, firms share their strategic information (Jarillo, 1988).

5.1.2.3. Community Capital

Community capital, as noted, is comprised of the relationships that arise through work-related interactions. Knowledge sharing is voluntary in such communities of practice. While organizations cannot directly impact such voluntary knowledge sharing, they can facilitate it (Stewart, 1999). This can be accomplished through ***data standardization, support for information sharing***, and ***conferences***. These measures are therefore used to operationalize community capital in the SCM context.

Data standardization provides a basis for connecting work-related people internally and externally. It is an essential tool for accurate and efficient data transfer. Success of SCM depends on the ability to support such a data standard (Nicholas, 2001). If each division uses its own data formats and identifiers, it is difficult to share information across divisions and at the enterprise level, which may prevents from having common knowledge among employees. Common knowledge is a foundation for knowledge sharing and transfer (Grant, 1996).

Support for information sharing sustains communities-of-practice and fosters knowledge transfer. It is therefore used to operationalize community capital. Information sharing may be facilitated via the provision of collaboration technologies and

the development of an organizational culture or programs conducive to information sharing. For example, Logility's Voyager XPS application has helped Heineken to share information across value chains (*PR Newswire*, October 13, 1999, Wednesday). AskMe Enterprise, a knowledge sharing program, enables firms to create a giant knowledgebase that can be accessed instantly throughout an organization (*Business Wire*, July 16, 2001, Monday). Once AskeMe Enterprise is integrated into a corporate Intranet, employees can identify qualified individuals with relevant expertise, submit questions or business problems to individuals and receive solutions from colleagues in order to take immediate and effective action (*Business Wire*, July 16, 2001, Monday). Deployment of technology is just a tool to facilitate information sharing, but organizations have to create a sharing culture in order for employees to voluntarily share information. One study shows that "the hesitancy to share information is a major barrier to interoffice cooperation" (Graves, 1999). Sharing information across divisions is critical for SCM to deliver value to the firm.

SCM conferences improve community capital by providing opportunities for employees to voluntarily share SCM-related information and knowledge across firms. Since participants are typically those with SCM-related responsibilities, or responsibility for planning, managing or directing SCM (http://www.ism.ws/Conferences/SMP04Front.cfm), they are more likely to have common knowledge about SCM-related issues and problems. Data standardization is also important because it creates a common knowledge among SCM users. Similarly, the use of disparate data formats across industries creates different knowledge communities within conferences. For example, XML is predominantly used in Chemical industries,

while EAN-UCC Systems are mainly adopted in international logistics management, especially packing companies (PPI, 2000).

5.1.2.4. Human Capital

Human capital has long been recognized as an important complementary investment. Although previous scholars have not differentiated between investment-specific and general training, it makes sense to do so because SCM requires unique skills as well as general business knowledge. A lack of SCM training has been one of the biggest barriers to optimizing value from these systems (Michel, 2003). SCM technologies place increasing demands on effective training programs because "myriad paths exist for employee training, some home grown, others outside, and combination of the two" (Anonymous, 2002, *Transportation and Distribution*). Therefore, ***SCM-specific employee training*** and ***general employee training*** are used as measurements of this construct. SCM-specific skills are ***technical skills, data analytical skills, data modeling skills***

Technical skills are required because although SCM software is sophisticated, unforeseen events or problems frequently arise (Friedman, 2002). If SCM creates a problem it could result in excessive customer returns or technical failure when it is fully automated. Therefore, it is imperative that technological personnel be able to understand the system and fix "bugs" when a problem arises (Friedman, 2002).

Data analytical skills are required in order for IT personnel to make sense out of the huge databases. Although a firm can get access to huge datasets from POS systems or from other firms' databases, if IT personnel don't understand the meaning of the data, the data cannot contribute to optimizing SCM value (Baker, 1999).

Data modeling skills are required forecasting skills for efficient inventory management and manufacturing functions. Forecasting is based on historical trends, future orders, and marketing activities and intelligence (Bellinger, 2000). However, the historical data quality is often very low (Bellinger, 2000), which jeopardizes the reliability of demand forecasting. In spite of the low data quality, one report claimed that without forecasting, firms may miss forecast up to 50% (Bellinger, 2000). Therefore, data modeling skills are imperative.

General employee training include ***interpersonal skills, vendor management skills,*** and ***service representative skill training***. SCM deals with a network of firms that require ***interpersonal skills*** such as the ability to communicate effectively (Gammelgaard and Larson, 2001). In particular, SCM managers need to be able to communicate efficiently with suppliers, listen and solve problems on time (Gammelgaard and Larson, 2001), and build consensus (Myers et al., 2004).

Vendor management skills are required for firms to make sure that contractual issues are fully resolved to support technical and deployment issues (*Manufacturing Engineer*, 2003). These skills also include the ability to develop and maintain high quality relationships with key vendors as the success of SCM mainly depends on the relationship with suppliers (*Manufacturing Engineer*, 2003).

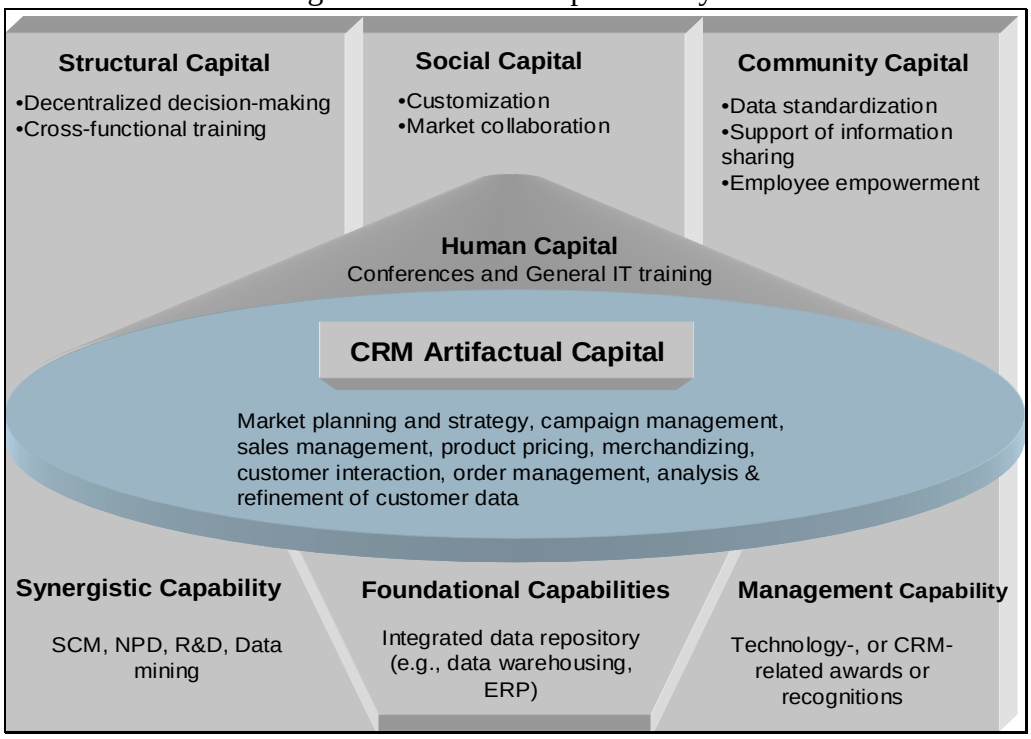
Sales representative skill training has been recognized one of the most important types of training in SCM because service representatives deal directly with buyers (Garrett, 2002). For many pharmaceutical firms, a skilled and highly motivated sales force frequently magnifies its market potential (Garrett, 2002). Regardless of how well

devised a market plan is, poor sales execution inevitably leads to poor sales (Garrett, 2002).

5.2. CRM

CRM enables an organization to tailor its products or services to customers' needs and requirements. Although CRM has the potential to increase firms' ROI and sales per employees, Garter Group reports failure rates as high 55% (Croteau and Li, 2003). The failure to commensurately invest in investments that complement CRM may very well be responsible for some, if not many, of these failures.

Figure 5.2: CRM Complementary Investments



This model provides a framework within which to consider specific investment elements required to complement a CRM investment. These complementary investments, identified through a review of the CRM literature, are summarized in Figure 5.2. Discussions of investment-related and investment-specific capabilities are provided.

5.2.1. Investment-Related Capabilities

We now consider the foundational, synergistic, and management capabilities pertinent to CRM.

5.2.1.1. Foundational Capabilities

Foundational capabilities in CRM are the ability to analyze customer data. In order to analyze customer data at the enterprise level, customer data from all sources has to be integrated. Such a capability can be best achieved through integrated data repositories. Data warehouses and ERPs are also included in this capability because they require data integration.

Integrated data repositories enable firms to integrate data from different customer data marts and to share data across different applications. This is an enterprise-level data repository. Data integration has been one of the biggest barriers deploying CRM successfully (Sweat, 2000). Less than 10 percent of enterprises have a single, company-side view of their customer – a critical stepping stone toward customer loyalty (Peikin, 2003). Firms often use legacy systems with different data definitions, formats, and identifiers, which creates inefficiencies in CRM. As businesses becomes increasingly global, integrated systems have gained importance in tying together geographically-dispersed organizations. They improve information visibility, process improvement across functions, and customer responsiveness.

Data warehouses store huge amounts of data and allow firms to analyze past and current customer data and predict future demand at the enterprise level (Swift, 2001). It serves as foundational capability in CRM by providing "integrated customer information, product profitability information, and distribution revenues and costs" (Goodhue et al.,

2002). Churn and profitability analyses may also be created using data warehouses and deliver value to the firm through marketing planning and strategy, and campaign management. Information about customers also enables firms to design cross-selling or up-selling.

ERP is complete software that supports operations and business processes. ERP software is consisted of a series of integrated modules. Each module supports business functions such as accounting, distribution, manufacturing, and human resources. Since they are incorporated into business process, the data in ERP are integrated. Major chemical companies have each spent hundreds of millions of dollars over the last 10 years in order to implement ERP to tie their database, order entry, and financial systems to business processes (Fattah, 2003). Therefore, deployment of ERP is a measure of integrated data repositories.

5.2.1.2. Synergistic Capabilities

Synergistic capabilities in CRM are ***NPD, R&D, data mining***, and ***SCM***. While these investments have a value independent of CRM, they also amplify the benefits of CRM.

NPD aims at creating "solutions that customers need and want" (Srivastava et al., 1999, p. 169). New products that meet customer needs improve sales (Singh and Mitchell, 2005). One report showed that more than 30,000 new products were introduced to the marketplace in 2003 (Duckler, 2003). However, fewer than 25% of those will ever achieve an annual retail sales level of $7.5 million (Duckler, 2003). This suggests the importance of customer information in the CRM database when a firm invested in NPD.

NPD is here a firm's investments in process, software, hardware that is designed to improve new product productions.

R&D enables firms to innovate and create new value for customers (Kanter, 1992). Such value creation is more important than zero defects. R&D entails ongoing new product research, launches, and testing them to understand responses of targeted customers. In order to perform this function, it is critical for R&D staff to have on-going relationship with the CRM division in order to access customer data (Srivastava et al., 1999). R&D is measured with the process and outcomes of R&D activities. For example, if a firm has been approved from FDA for a drug research, it is considered as a beginning sign of R&D. If a firm commercializes the new drug, it is an outcome of R&D activities. R&D provides high sale capabilities to CRM by providing products in demand.

Data mining is an analytical tool that recognizes patterns of customers buying behaviors and anticipates customers' requirements and expectations from customer database. It also enables the discovery of new knowledge about customers that has not been previously detected (Chye and Gerry, 2002). In a typical application, data mining identifies customers who are profitable and who are likely to leave or churn (Swift, 2001). Since it supports firms' marketing strategy by analyzing customer information, it is not a business solution itself, but it is an enabling technology (Nemati et al., 2003) that amplifies the value of CRM.

SCM amplifies economic benefits of CRM by enhancing the speed of provision of raw materials and improving internal efficiency and responsiveness through elimination of waste and better use of internal and external supplier capabilities and technology

(Morgan and Monczka, 1996). Without having supply chain information, efficient market planning and customer interaction will be significantly limited. In order to amplify the benefits of CRM, demand forecasting and inventory management should be coordinated.

5.2.1.3. Management Capabilities

Management capabilities are operationalized as the IT-, and CRM-related awards or recognition received by an organization. Although few CRM-related awards are available, the same criteria for SCM-related award may be applicable to CRM-related awards. Since technology-related awards have already been discussed in the SCM section, only CRM-related awards are discussed here. One CRM award noted was given to Dean Foods Company was for its excellent customized relationships (*Business Wire*, October 26, 2001, Friday).

5.2.2. Investment-Specific Capability

We now consider the operationalization of structural, social, community, and human capital as they constitute the CRM capability.

5.2.2.1. Structural Capital

The main objective of CRM is to satisfy customers and increase sales. This objective can be best achieved through meeting customers' needs and requirements in a timely fashion. In order to meet these needs promptly, ***decentralized decision-making*** was noted to be important. As discussed earlier, decentralization decision-making must be accompanied by ***cross-functional training***.

Decentralized decision-making is important to CRM investments since their value depends on a quick response to the different segments of customers, who require

different products and services, and to rapidly-changing demands. As with SCM, decentralization necessitates an integrated logic across functional areas. The marketing division must know what the production division is producing or designing. This can be facilitated through cross-functional training.

Cross-functional training facilitates understanding of other divisions' activities and information requirements. It provides an understanding of the fine line between high sales and risk management, and promotes an understanding of what kind of information is needed by other divisions (Drucker, 2005). Cross-functional training enhances the value of CRM by creating an agile workforce (Hopp and Van Oyen, 2004). Also high rates of CRM failures (55-75%) may be due to lack of communication across functional teams (McDonnell, 2001).

5.2.2.2. Social Capital

Here, we consider how social capital is operationalized in the context of CRM investments. The main objective of CRM is to increase selling through customization. This objective may be achieved through product ***customization*** and ***market collaboration***.

An efficient way to achieve product ***customization*** is through employee-customer interactions (Nambisan, 2002). Customers are important sources of new product development and product defects. ***Customization*** can enhance product selling and creates high exit barriers for customers by providing what they want (Roche, 2005).

Market Collaboration provides member firms with market information about consumer trends, market research data and customer databases (*Soap, Perfumery & Cosmetics*, 1997). This information enhances customer relationship management.

Market collaboration commonly takes place between or among brands in order to acquire or retain more customers. It allows a business to leverage some of its brand and customer equity by selling products and services to customers. Since the companies tend to have complementary products rather than competing brands, the project could result in joint market promotions. One example is that of Unilever and Kimberly-Clark combining their efforts to target the mother and baby market through Unilever's Vaseline, Persil and Comfort conditioner and Kimberly-Clark's Huggies nappies (*Soap, Perfumery & Cosmetics*, 1997). Market collaboration also allows firms to access new markets, including those in different countries or market segments. For this reason, market collaboration (also known as affinity marketing) budgets have risen by 4% in the last two years (Hanson and Fisk, 2003).

5.2.2.3. Community Capital

Community capital associated with CRM is operationalized in terms of ***data standardization***, ***support for information sharing***, and ***employee empowerment***. Since knowledge sharing, which is integral to CRM, requires common knowledge, data standardization and support for information sharing are important in sustaining communities-of-practice. Employee empowerment enables employees to act upon shared information. ***Data standardization*** provides a basis for sharing customer information across different functional areas such as engineering, support of sales, and marketing. An information sharing capability, derived from data standardization, is especially critical for aggregating and analyzing data, and discovering customers' needs. It also enables firms to view customer information at the enterprise level and to share information about

products and customers based on the consolidated data, and thus serves as a basis for creating common knowledge.

Sharing information is a community-based, voluntary behavior. However, firms often provide software that supports such information sharing and nurtures a sharing culture. Examples of such software include eRoom and AskMe. Thus, we operationalize community capital for CRM in terms of such ***support for information sharing.*** When customer information is not shared, employees do not understand what other divisions are doing or who are the customers (McDonnell, 2001), which results in inefficient customer relationships. Currently CRM providers acknowledge the importance of sharing information, and integrate this function within CRM functionalities. ePeople Teamwork 4.0, a CRM software, offers a teamwork function that provides a real-time view into customer inquires in a collaborative environment. The Web-based application allows companies to work with multiple contacts at a customer's site and with internal and third-party service and support personnel to resolve problems and provide needed information to customers (Maselli, 2002). This software also identifies and acquires the best team to resolve each complex issue (Anonymous, *Customer Inter@ction Solutions*, 2002). In conjunction with information sharing software, an organizational culture of sharing facilitates information exchange. One of the most frequent causes of CRM implementation failure is lack of a culture of knowledge sharing (McDonnell, 2001). Therefore, deploying knowledge sharing software and sharing culture facilitate voluntary knowledge transfer.

Employee empowerment enables CRM users to deal with the exceptions and problems stemming from the rapidly changing nature of CRM environments. In such a

case, users often possess the practical knowledge that can aid problem-solving. When employees are empowered to act upon their knowledge, they are better able to contribute to the achievement of CRM objectives, namely offering superior products and service to the customer. It is especially critical that call center agents be empowered to respond appropriately to customer needs and demands (Schafter, 2001). Furthermore, CRM functionalities are frequently varied and upgradeable and different communities may best be served by a different set of functionalities (Gelinas and Markus, 2005). Empowering communities to select CRM functionalities that fit their needs enables them to develop their own efficient ways to address their distinctive needs. Employee empowerment is therefore an important component of community capital in the CRM context.

5.2.2.4. Human Capital

In the CRM context, human capital is considered in terms of ***general IT training*** and employees' attendance at ***CRM conferences***.

General IT skill training imparts knowledge to employees across a wide range of technical tools and platforms (Schafter, 2001). An important CRM functionality for sales is sales force automation (SFA), which is increasingly adopted to support customer relationships; however, SFA failure rates are high (Speier and Venkatesh, 2002). A study based on 454 salespeople across 2 firms showed that one of the main reasons for SFA failure is a lack of technical training. Another study showed a similar finding in that 25% of the firms offered no training to support their SFA efforts. The respondents with no SFA training reported that their organizations did not achieve the objectives of SFA (Erffmeyer and Johnson, 2001). Technical training improved the salespeople to access to

customer information and to effectively communicate with their clients, which in turn enhanced salespeople's performance (Ahearne et al., 2005; Buehrer et al., 2005).

CRM conferences help organizations get up to speed quickly with new technologies. Attendance at such conferences is here included as an operationalization for human capital because CRM deployment is relatively recent compared to that of SCM. Thus, CRM conference attendants can still expected to learn about strategic use of CRM, its functionalities and potential problems.

5.3. Dependent Variables in SCM and CRM Analyses

Table 5.1 shows the dependent variables that are used for the SCM and CRM analyses. The selection of each performance variable is based on previous SCM and CRM literature that explored the effect of the deployment of SCM and CRM on firm performance. The source of these dependent variables is all from COMPUSTAT.

Table 5.1: Dependent Variable Calculation

Category	Financial Measurement	Components of Measurement	Context
Operational Efficiency	Inventory Turnover	Cost of Goods Sold (COGS[#]) / Average Inventory	SCM
	Net Cash Flow	Cash Dividends + Capital Expenditure + Cash Receipts + Cash Payments	SCM, CRM
	Gross Profit	Sales Revenue – Cost of Goods Sold	SCM, CRM
	Earning Before Interest, Taxes, Depreciation and Amortization	Earnings – Cost of Goods Sold – Operating Expenses – Taxes	SCM, CRM
	Sales per Employee	Sales / Total Employees	CRM
Capital Efficiency	Return on Asset	Net Income – Total Asset (average of the beginning and the ending period)	SCM, CRM
	Return on Investment	Income – Book Value of Asset	SCM, CRM

[#]COGS (or Sales Costs) includes labor costs that are used for production and inventory costs.

The explanations of the dependent variables are organized based on those related to operational versus capital efficiencies. Operational efficiency refers to producing outputs at the lowest possible costs (Smart et al., 2004), while capital efficiency represents achieving maximum outputs from a given capital investment. SCM improves operational efficiency through internal and external connectivity and through enhanced material and information flow, and CRM enhances also operational efficiency by facilitating sales. Capital efficiency can be also improved through the deployment of SCM and CRM. SCM enables firms to improve inventory turns without having large warehousing investments and high levels of inventory, and CRM can also enhance capital efficiency by providing information about the correct quantity of customer demand.

5.3.1. SCM Dependent Variables

As shown in Table 5.1, the selected operational efficiency variables in SCM are ***Inventory Level***, ***Net Cash Flow (NCF), Gross Profit (GP),*** and ***Earning Before Interest, Taxes, Depreciation, and Amortization (EBITDA). Return on Asset (ROA), and Return on Investment (ROI)*** variables are included here as capital efficiency variables.

Operational Efficiency Variables

Inventory Turnover: SCM functionalities enable firms to improve inventory turnover by controlling inventory level. Inventory management functions in SCM provide real-time inventory information that enables firms to control inventories sitting unused. Dominant inventory functions in SCM are CPFR and VMI. The development of Collaborative Planning, Forecasting, and Replenishment (CPFR) evolved from Vendor Managed Inventory (VMI), which again evolved from Quick Response (QR) (Gelinas

and Markus, 2005). Although QR was designed to perform many functions including cross-docking, automatic inventory replenishment and forecasting, and transfer of inventory function to supplier, it was mainly used as an inventory reduction function. Continuous replenishment function is accomplished through VMI in which "vendors create purchase orders for retailers, using the vendors' analysis of retailers' point of sale data and jointly agreed objectives; some analysts restrict the term VMI for the special case of QR in which retailers also transfer ownership of their inventory to the vendors, reaping additional gains" (Gelinas and Markus, 2005, p. 4). However, VMI does not have the capability to process demand under uncertainty and the demand forecasting functionality. CPFR enables "the forecast calculation to incorporate specific information about how much of an item will actually be available for delivery at some future date … while satisfying customer needs" (Gelinas and Markus, 2005, p. 4). CPFR is by definition "the sharing of forecast and related business information among business partners in the supply chain to enable automatic product replenishment" (http://www.auditmypc.com/acronym/CPFR.asp).

VMI enabled some firms to improved inventory turns up to 400% (Hill, 1999). Kmart, Wal-Mart, and Woodward Industrial Controls also increased inventory turns significantly through VMI (Hill, 1999; Duffy, 2003). Thus, using VMI and CPFR, firms are able to better inventory turns, while reducing out-of-stock items and feed sales (Bednarz, 2004).

Net Cash Flow (NCF): This is a measure of a firm's financial health (http://www.investorwords.com/768/cash_flow.html). Unlike other financial measurements, this measure includes Capital Expenditure, which provides information on

a firm's investment on physical assets. SCM increases cash flow by freeing up inventory and by facilitating efficient inventory turn over (Bradshaw, 2002; Augustine et al., 2004). Online billing and payments also facilitate cash flow, and they have become normal operating protocol for business (Platt, 2001).

Gross Profit (GP): SCM reduces time to market and improves product availability, which leads to a firm's profitability from sales. As shown in Table 5.1, the calculation of GP includes sales revenues and COGS. SCM also lowers COGS by reducing inventory costs and by improving inventory turns. An empirical study shows that it increased 23.4% among the mature SCM companies and 10.9% in inventory turns among immature SCM companies (Hadley, 2004). Another study shows that SCM increased 1%-5% in sales (Anonymous, *Chemical Week*, 2002). VMI and CPFR also enable firms to better manage expenses (Bednarz, 2004), thereby increase GP.

Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA): While some argue that EBITDA is a measure of cash flow, others disagree because it excludes some cash items (interest and taxes), but not others (depreciation and amortization), and it does not include the changes in working capital, which consumes cash (http://www.valuebasedmanagement.net/methods_ebitda.html). Since it does not include capital expenditures, critics often argue that it is not a good measure for those firms that go through frequent technological changes or restructuring processes (McDonnell, 2001). However, since it measures earnings before interest, taxes, depreciation and amortization, it provides insights on a firm's financial performance before the firm applies different accounting methods. Thereby it provides different insight into a firm' operational performance. This measure is therefore less susceptible to

the distortion accounting and financing effects on company earnings because it is before a firm makes a decision on tax, depreciation, and amortization (http://www.investorwords.com/5534/Earnings_Before_Interest_Taxes_Depreciation_and_Amortization.html). As shown in Net Cash Flow, the inclusions of items are different across NCF, GP, and EBITDA. EBITDA provides more insights on the efficient use of SCM because it includes operating expenses while GP and NCF don't include this item.

Empowered by VMI and CPFR, firms are able to better control their inventory levels and reduce the size of warehouse while meeting customers' needs. When a company's inventories are high, it causes much of its capital to be tied up in unsold goods. All these contribute to enhancing operational efficiencies. For a company with $500 million a year in sales, the supply-chain efficiency can mean $25 million to $30 million in savings. Market leaders with sound supply-chain strategies are earning 75 percent higher profit than their less successful competitors (Atkinson, 1999). Hershey Foods Corp. increased 31% in net income, which is derived from reduced logistics expenses and improved supply-chain efficiencies (*Wall Street Journal*, Jul. 23rd 2001).

Capital Efficiency Variables

Return on Asset (ROA): One of the main advantages of SCM is a reduction of asset utilization. SCM enables firms to discover customers' needs (through CPFR) and to produce correct quantities, thereby reduce product waiting in storage (ebiz.enable, 2004, http://strategis.ic.gc.ca/epic/internet/inee-ef.nsf/en/h_ee00379e.html).

Cross-docking also reduces a firm's assets as it takes finished goods from the manufacturing plant and deliver these directly to the customer with little or no handling in between, or it means receiving goods at one door and shipping out through the other

door almost immediately without putting them in storage (http://projects.bus.lsu.edu/independent_study/vdhing1/othertopics/crossdocking.htm). Cross docking also helps retailers streamline the supply chain from point of origin to point of sale. It helps reduce operating costs, reduces inventory levels, and helps in increase of sales space (http://projects.bus.lsu.edu/independent_study/vdhing1/othertopics/crossdocking.htm).

CRFR enables firms to predict and manage customer demand effectively for enhanced customer service and lowering operating costs and higher profitability. For example, one study shows that it increased fixed asset utilization over 10% and revenue by 1% for every 5% improved accuracy (http://www.arches.uga.edu/~chrisjt/benefits.html). It also reduced inventory level by 10%-40% and increased gross margin by 5% in high tech consumer electronics (http://www.arches.uga.edu/~chrisjt/benefits.html). In pharmaceuticals, sales were increased due to better forecasting and more throughputs with the same assets (http://www.arches.uga.edu/~chrisjt/benefits.html). In the same industry, ROA is increased by 2% through improved asset utilization and avoidance of fixed asset expansion. CPFR provides a prompt response based on the demand rather than a firm's independent forecast or prediction (Sabath et al., 2001). The response-based inventory system outperformed the forecast-based system (Sabath et al., 2001).

Return on Investment (ROI): It measures a corporation's profitability on how effectively a firm uses its capital to generate profit. Dow Corning standardized its SCM and reduced working capital of almost 20% (Kodoman, http://www.softwareapplicationdirectory.com/Supply_Chain_Management/Articles/time_

to_benefit.html). Raytheon Co. (Lexington, MA) reduced inventory by 11% and increased ROI (Kodoman, http://www.softwareapplicationdirectory.com/Supply_Chain_Management/Articles/time_to_benefit.html).

5.3.2. CRM Dependent Variables

The operating efficiency variables in CRM are ***Sales per Employee, Net Cash Flow (NCF), Gross Profit (GP), Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA). Return on Assets (ROA), and Return on Investment (ROE)*** are selected as capital efficiency variables.

Operational Efficiency Variables

***Sales per Employees*:** CRM improves sales through the SFA (sales force automation) functionality by enabling sales forces to view all contact and account information and history about customers. Also this functionality allows the sales forces to access pricing levels, options for different customer segments, forecast sales, and identify top opportunities of sales (http://www.ioko.com/DAIS/CRM/CRM+Solutions/Microsoft+CRM+for+Sales.htm). These functionalities inform the sales associates of customer preferences and product sales strategy.

CRM provides consolidated information about customers. For example, standardized data and CRM tools enabled Fleet (a financial firm) to more quickly close deals, and the sales team increased cross-sell revenue from $870 million in 2000 to a projected $1.15 billion in 2002. The number of products sold per customer also is up from an average of 4.6 products in the second quarter of 2001 to 5.7 in the first quarter of

2002. In particular, sales of non-credit products, such as leasing and investment services, have reduced Fleet's dependency on credit revenue derived from loan interest (http://www.networkworld.com/news/2002/0701fleetboston.html).

CRM also increases sales via cross-selling, up-selling, analyses of customer demands and requirements by different regions, ethnicity, and ages, and enables firms to customize products. For example, OneSource allowed firms to segment a sales territory and highlighted the marketing strategies with accurate data, which improved sales (Dickie, 2004). OneSource aggregated data from 2,500 external data sources and made it available to salespeople via the company's existing CRM application framework and provided the company's profitable potential marketing territories along with marketing strategies (Dickie, 2004). CRM also enables the sales representatives to access various customer information such as distance, size of business, or business types along with different products relevant to these segments of customers (Lange, 2003).

Net Cash Flow (NCF): A firm's cash flow is directly derived from customers' product purchase or customer tenure (Hansotia, 2004). As discussed, CRM improves a firm's sales through customization and customer satisfaction. In turn, high product sales increase cash flow. Increased cash flow is derived from the improved sales and the reduction in collectibles time, which has dropped an average of 10 days (Anonymous, *Customer Relationship Management*, 2004).

Gross Profit (GP): As discussed, CRM improves sales per employee. The increased sales per employee in turn enhance Sales Revenue. The essence of CRM application merges islands of relationship information systems into one comprehensive database (Kennedy and King, 2004). CRM customer data help in analyzing customers'

changing needs and requirements by eliciting personal data, which are bases for customized products and services. Customization makes for better customer service and satisfaction. Since CRM customer data allows firms to analyze the segment of profitable customers and customer churn, firms can strategically plan on customer retention through loyalty programs, which will lead to a firm's GP.

Siebel, a software provider, surveyed its customers with regard to CRM profitability. The customers reported an average 16% - 21% increase in revenue depending on customer loyalty and staff efficiency (McLuhan, 2001). Nissan Motors implemented a CRM contact center solution in order to weed out brochure collectors from those likely to make an actual purchase. That resulted in raising the first contact- to sales rate from 2 % to 8% (McLuhan, 2001). Although one of the main objectives of CRM is to satisfy customers and increase sales, firms report cost savings as well. One Boise consolidated business units and IT systems and saved more than $3.5 million annually (Dragoon, 2002). However, the senior vice president of marketing claimed that customer retention was up dramatically since the CRM project launched.

Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA): As discussed, CRM increases sales and firm performance. For example, Fleet, a financial firm, consolidated customer information using data standardization and was able to quickly close deals, and the sales team managed to increase cross-sell revenue from $870 million in 2000 to a projected $1.15 billion in 2002 (http://www.networkworld.com/news/2002/0701fleetboston.html). Although Operating Expenses, which is different from other financial measurements such as GP and NCF, can effectively achieved through SCM, CRM also enables firms to increase sales and

reduced COGS. Since CRM increases Sales per Employee, targets correct and profitable customers, it can reduce COGS as well.

Capital Efficiency Variables

Return on Assets (ROA): Firms deploying CRM can increase the value leveraged from their Assets because if they attract their existing customers to new product markets through cross-selling and up-selling. This is possible because CRM functionalities enable firms to discover customers' preferences and needs, and to discover profitable customers. Market collaboration in particular will increase the value of Total Asset. Market collaboration allows a business to leverage some of its brand and customer equity by selling to customers extra products and services, and also firms to reduce capital required for the new product market by leveraging the partnering firm's secured market (Hanson and Fisk, 2003).

Return on Investment (ROI): Strategic use of CRM increases income through the analyses of price strategy, product profitability, and profitable customer segment. A study from International Data Corp based on over 30 large firms in 2004 reported that 57 percent of respondents achieved a positive ROI from CRM deployment within one year, and 93 percent achieved a positive ROI within three years (Aldhizer and Cashell, 2004).

5.4. Control Variables

Industry strategic IT industry and firm size are used control variables. Industry strategic IT role is categorized based on Chatterjee et al.'s (2001) study: ***transforming, informate up/down, and automating industries***. This construct has been included as an important discriminating IT performance. The same logic is expected to be applicable to

CRM and SCM deployment. A widely employed measurement of firm size is log number of employee (McEvily and Zaheer, 1999; Kraut et al., 1999).

5.5. Summary of Operationalization of Complementarity

This section has explicated the roles of SCM and CRM and discussed the development of operationalization of constructs in the context of SCM and CRM. The relationship between the constructs and operationalization was based on the KBV and prior research on SCM and CRM. As discussed, prior research has not clearly distinguished between social and community capital. We operationalized these two concepts in the SCM and CRM contexts. In addition, the operationalizations of the remaining constructs are offered: foundational, management, synergistic capabilities. The next section discusses data collection methods and analyses.

CHAPTER VI: RESEARCH METHODS

This chapter describes the study's sampling strategy, data sources and coding strategies. It also outlines the analyses to be performed in assessing the research hypotheses proposed in Chapter 4.

Research data will be drawn solely from secondary sources. As discussed earlier, the focal IT investments being examined are deployments of SCM and CRM. Since most SCM and complementary investments took place between 1994 and 2003, and those of CRM were between 1997 and 2003 as shown in Table A7.1, the search for key words was conducted for those periods. Fewer threats to validity exist when using secondary data than when using primary data. Potential validity threats to primary data are as follows. First, if a primary data collection method (e.g., survey) were employed, respondents may not remember all relevant facts. Second, a firm may have a new CIO who may not know the year the firm deployed SCM and CRM as well as other complementary investments. Third, the targeted respondents may not answer the questions. Fourth, the complementarity constructs deal with different organizational domains (e.g., manufacturing, IT management, HR), which make it difficult to identify and reach all respective respondents. Fifth, a concern with the survey method is the response rate.

Secondary data sources also have some potential problems. Specifically, the data are not designed to address the specific research question posed by a study. However, in the case of this research, secondary sources do provide evidence of complementary investments. An added advantage of secondary data is the elimination of respondents'

response biases such as social desirability that characterize survey methods. Therefore, secondary data sources are chosen for this dissertation.

6.1. Sampling Strategy

There are many different kinds of sampling methods available such as random, stratified, cluster, and systematic sampling. This dissertation employs a stratified sampling method because this method recognizes the characteristics of distinct subpopulations, or strata within a population. Research has shown that strategic uses of IT are substantially different across different industry types (e.g., Chatterjee et al., 2001). Since this dissertation explores the value from complementarity investments, in order to observe the value from these investments, industry effects must be controlled. Sample strata for this study were therefore the industry strategic IT role.

The stratified industries were drawn from the same value chain, but represented distinctively different industry categories. Value chain describes the activities of firms that add value along the way to the ultimate transacted good or service. For example, fertilizer & agricultural chemicals produce raw materials for chemical compounds (automate industry), pharmaceuticals process and transform these raw material into drugs (transformate industry), and then drug retailers sell these products (automate industry). This method may minimize the effects of environmental changes such as economic cycles or technological innovation that may specifically impact a certain industry.

Potential sample frames were drawn from the COMPUSTAT database. To be selected, sample frames needed to be comprised of firms located within the same value chain but representing distinct industry types. In order to select an appropriate value chain and identify potential problems with this approach, a preliminary analysis of two

candidate sample frames – publishing & printing and pharmaceuticals industries – was conducted.

Preliminary data collection for the Publishing & Printing industry demonstrated some problems that would threaten the validity of this research. While firms in the Publishing & Printing industry category offer services such as newsmagazines and newspapers, some of those firms were also involved with software development, including SCM and CRM software. Those firms tend to serve as leaders or champions in implementing the software, and are believed to strategically deploy SCM and CRM. Therefore, those firms may distort the assessment of complementary investments across firms. In contrast, firms in the pharmaceutical industry did not demonstrate any significant problems that would jeopardize the objective of this research. Therefore, the pharmaceutical industry value chain was selected.

Pharmaceuticals are categorized as exhibiting a transform IT industry strategic role. The underlying characteristics of pharmaceuticals are to utilize technology to fundamentally alter R&D and business processes to provide new products and services to customers. R&D processes are radically changed and innovated due to technology (Brannback et al., 2001). By investing IT for business transformation, those firms can maximize the economic benefits of IT investment. Pharmaceuticals also utilize portals for R&D (Greenemeier, 2002). For example, Eli Lilly's IT department is helping the company's scientists improve data collection and collapse research cycle times with a suite of technology. Reducing cycle times also helps drug-makers reap greater revenues in the long term. It commonly takes about 15 years and $800 million to bring a drug to a market (Greenemeier, 2002). The Optimizing Lead Optimization software helps

researchers identify which chemical compounds are most likely to become the building blocks for new drugs. Reducing cycle times also helps drug-makers reap revenue in the long term because pharmaceutical companies receive patents for their products when a drug molecule is first discovered (Greenemeier, 2002). Every year that Lilly can eliminate from their innovation research process is worth about $3 billion (Greenemeier, 2002). Therefore it is critical that pharmaceuticals transform the drug discovery process to make it fast and successful through technology.

The value from IT in our industries exhibiting an informate industry IT strategic role -- drug retail, food retail, and packaged foods -- is mainly derived from fast and accurate information transfer. For example, as a retail store sells products, the data have to be stored in a database and transmitted to headquarters in order to control inventory. These industries may not fundamentally change their business processes in order to survive, however their value chains are located in fast and accurate information transfer. Therefore, the capability of immediate information transmission is also essential (Duschene, 1999). The US Food and Drug Administration estimated that bar code labeling on prescription drugs is projected to reduce errors by 500, during the next 20 years and save an estimated $93 billion in additional healthcare costs (Rios, 2005). The bar code label also significantly reduced medical errors (Mullen, 2003). Therefore, IT facilitates accurate information transfer while saving money in health care industries.

The industries in this value chain with an automate industry IT strategic role are fertilizer & agricultural chemicals, agricultural products, diversified chemicals, and household products. These industry categories represent a main value chain that is resided in process (or production) automation using IT (Woodruft, 2001). For example,

the agricultural industry automated its operation using robots to save labor costs (Burgess, 2001). The employees in the industry had to carry many thousands of bags of seeds to warehouses. Any given bag of seed commonly weights between 50 and 60 lbs. A management and engineering team was asked to propose a system to eliminate some or most of the physical labor involved in moving these packages. Currently, work crews of four or more individuals are assembled to perform the whole task where previously three or four people needed to carry one bag of seed. The robots reduced labor and costs significantly and reduced injury potential, down time, and errors (Burgess, 2001).

Based on these industry criteria, the following industries are identified for this research sample. The sample size and the list of firms are drawn from the COMPUSTAT database.

Table 6.1: Sample Frame

Category	Industry	Sample size	Total
Transformate	Pharmaceutical	165	165
Informate up/down	Drug Retail	14	176
	Food Retail	37	
	Packaged Food	125	
Automate	Fertilizer & Agricultural	25	85
	Agricultural Product	21	
	Diversified Chemical	21	
	Household Products	18	
Total			**426**

6.2. Data Sources

As discussed above, the data were collected from the secondary sources. First, the *LexisNexis* database was searched. Search criteria were 'Business News' – with subcategories of 'Industry News' and 'Business & Finance' – and 'SEC Filing' – with the subcategories of 'SEC 10-K Report' and 'SEC Annual Reports to Shareholders.' Second,

news articles from 'ABI/INFORM Global' and 'Business Source Elite' were searched. Third, an award website (http://www.cwheroes.org/caa_4_a.asp) and CRM and SCM associations were searched for evidence of awards and to complement other information. Fourth, COMPUSTAT data were used to assess the dependent variable and firm size. The 1994 to 2003 period was selected because the period includes high levels of deployment of SCM and/or CRM. Finally, the industry strategic IT role variables are categorized based on research from Chatterjee, Richardson, and Zmud (2001). Tables 6.2 and 6.3 show item operationalization and respective data sources for SCM and CRM.

Table 6.2: SCM Operationalization and Data Sources

Dimensions		Operationalizations	Data Sources
Investment -specific capabilities	Artifactual capital	Inventory management, Warehousing, Logistics and transportation management. Product pricing, Sourcing strategy, Data analysis & refinement, e-commerce capability, POS	♦ Business & Finance (business week, business wire, industry week, The New York Times, PR newswire, CIO magazine, pharmaceutical business news, supply chain management review) ♦ Industry News (business wire, computerworld, daily news, informationweek, supply chain reports, CIO insights, computerwire) ♦ ABI/INFORM Global ♦ Business Source Elite ♦ SEC Annual Reports to Shareholders ♦ SEC 10k reports ♦ CRM and SCM conference attendance or membership
	Structural capital	Decentralized decision-making Cross-functional training	
	Social capital	Vendor managed inventory Supplier-vendor relationship	
	Community capital	Data standardization Support of sharing information Conferences	
	Human capital	General IT training SCM-specific training	
Investment -related capabilities	Foundational capability	Manufacturing capability	
	Synergistic capability	CRM, NPD	
	Management capability	Technology-, or SCM-related awards or recognitions	
Dependent variables		inventory turns, net cash flow, gross profit, EBITDA, ROA, ROI	♦ COMPUSTAT
Control variables		Industry strategic role	Chatterjee, Richardson, and Zmud (2001)
		Size	COMPUSTAT

Table 6.3: CRM Operationalization and Data Sources

Dimensions		Operationalizations	Data Sources
Investment-specific capabilities	Artifactual capital	Market planning and strategy, campaign management, sales management, product pricing, merchandizing, customer interaction, order management, analysis & refinement of customer data	♦ Business & Finance (business week, business wire, industry week, The New York Times, PR newswire, CIO magazine, pharmaceutical business news, supply chain management review) ♦ Industry News (business wire, computerworld, daily news, informationweek, supply chain reports, CIO insights, computerwire) ♦ ABI/INFORM Global ♦ Business Source Elite ♦ SEC Annual Reports to Shareholders ♦ SEC 10k reports ♦ CRM and SCM attendance or membership
	Structural capital	Decentralized decision-making Cross-functional training	
	Social capital	Customization Market collaboration	
	Community capital	Data standardization Support of information sharing Employee empowerment	
	Human capital	Conferences General IT training	
Investment-related capabilities	Foundational capability	Integrated data repository (e.g., data warehousing, ERP)	
	Synergistic capability	SCM, NPD, R&D, Data mining	
	Management capability	Technology-, or CRM-related awards or recognitions	
Dependent variables		sales per employee, net cash flow, and gross profit, EBITDA, ROA, ROI	COMPUSTAT
Control variables		Industry strategic role	Chatterjee, Richardson, and Zmud (2001)
		Size	COMPUSTAT

6.3. Coding Strategies

A keyword search is used for the data collection of this dissertation. It has two steps. The first step is to identify whether a firm deployed SCM or CRM, and the second step is to find out whether those SCM- or CRM-deployed firms invested in complementarities.

The first step will be performed using the key words of SCM and CRM along with a firm's name. More specifically, 'SCM,' 'supply chain,' or 'supply chain management,' and 'CRM,' 'customer relationship,' or 'customer relationship management' will be searched along with a firm's name in 'Business News' with the subcategories of 'Industry News' and 'Business & Finance' in *LexisNexis* database.

'Business News' allows one to select five publication sources. The five selections will be 'Business Wire,' 'Computerworld,' 'Daily News (New York)' 'Informationweek,' and 'Supply Chain Reports.' 'Supply Chain' will not be used as it was not published prior to 2002, placing it outside of the data collection period of this dissertation. The keyword will be searched from the full text option in the database. Also the terms, 'SCM,' and 'supply chain,' 'supply chain management,' and 'CRM,' 'customer relationship,' and 'customer relationship management,' will be searched in 'SEC Annual Reports to Shareholders' 'SEC 10-K Reports' in *LexisNexis* database. From this procedure, CRM and SCM-deployed firms will be identified. Those identified firms will be in the research sample, and thus complementary investments will be searched for those firms only.

Second, the complementary investments (structural, social, community, and human capital) will be searched for starting from two years before CRM and/or SCM deployments until 2003. The search criteria are based on the definition of complementarity; '*investment complementarities entail prior or concurrent investments in ancillary business and technological assets and changes in existing technological and business processes.*' The same data sources that are used for the first procedure identifying SCM and CRM deployment will be used here for the complementary investment search. In addition, 'ABI/INFORM Global' and 'Business Source Elite' will be used. These sources provide a detailed story about a focal firm's complementary investments. Since these sources are a relatively independent of the focal firms, their announcements may capture the importance of an announcement. An announcement often contains multiple firms and thus may not be a part of this research sample. Since the key word search will be performed using a firm's name, the context bolds the key

word and the firm's name. These bolds will locate necessary information quickly. Another method to screen out unnecessary information is that when an announcement contains information about many firms, firms' names commonly appear in the first line of paragraph. Each complementary search word is included in parentheses in Tables 6.4 and 6.5.

Table 6.4: SCM Operationalization and Search Words

Dimensions		**Measurements (*Search Words*)**
Investment-specific capabilities	Structural capital	Decentralized decision-making (***decision making, decentralized, decentralization***) Cross-functional training (***cross-functional, cross-teamwork, cross-team***)
	Social capital	Vendor managed inventory (***VMI, vendor managed***) Supplier-vendor relationship (***CPFR, collaborative planning, partnering relationships, collaborative planning, collaborative relationship, collaborate***)
	Community capital	Data standardization (***EAN.UCC; UPC, UCCNet-a subsidiary of UCC; XML, EFS Network-EAN.UCC provider, Java; RFID (radio frequency), IRI (provider), mpXML (for meat/poultry industry***) Support of sharing information (***knowledge sharing, information sharing, sharing culture, support share***) SCM-conferences
	Human capital	General IT training (***technology training, IT training***) SCM-specific training (***interpersonal skill, logistics skill, decision-making skill, vendor management skill***)
Investment-related capabilities	Foundational capability	Manufacturing capability (manufacturing, manufacture)
	Synergistic capability	CRM (CRM-deployed firms), NPD (***new product, product development***)
	Management capability	Technology-, or SCM-related awards or recognitions (***award*** or ***winner*** in conjunction with supply chain or technology)

Table 6.5: CRM Operationalization and Search Words

Dimensions		Measurements (*Search Words*)
Investment-specific capabilities	Structural capital	Decentralized decision-making (***decision making, decentralized, decentralization***) Cross-functional training (***cross-functional, cross- teamwork, cross-team***)
	Social capital	Customization (***customized, customization, personalized, personalization***) Market collaboration (***collaborate, collaborating, collaboration***)
	Community capital	Data standardization (***EAN.UCC; UPC, UCCNet-a subsidiary of UCC; XML, EFS Network-EAN.UCC provider, Java; RFID (radio frequency), IRI (provider), mpXML (for meat/poultry industry***) Support of sharing information (***knowledge sharing, information sharing, sharing culture, support share***) Employee empowerment (***empowering, employee empowerment, employee empower, empowering employee***)
	Human capital	CRM-conferences General IT training (***technology training, IT training***)
Investment-related capabilities	Foundational capability	Integrated data repository (***integrated data, data repository, data warehousing, data warehouse, ERP, enterprise resource***)
	Synergistic capability	SCM (SCM deployed firms), NPD (***new product, product development***), R&D (***research and development, R&D, new product***), Data mining (***data mining***)
	Management capability	Technology-, or CRM-related awards or recognitions (***award*** or ***winner*** in conjunction with customer relationship or technology

Once a complementary investment is identified, the investment is assigned to a value depending on its strength. If there is no search word found in a specific complementarity, it is viewed as an absent of the investment, thus it is assigned '0.' If a firm intends to invest in a specific complementarity, it is seen as a weak sign of an investment, thus '1' is assigned. If a firm made a contract in order to invest in a complementarity, then it is seen as stronger than a simple intention, therefore a higher value, '2' is assigned. If a firm is conducting a pilot test on a complementary investment, it is viewed as one step stronger than a contract, therefore, '3' is assigned. If a firm implemented a specific complementarity in the past, it is '4.' Finally, if a firm won an award in a specific complementary investment, it is assigned the highest value, '5.' The summary of coding rules is provided in Table 6.6.

Table 6.6: Coding Rules

Category	Assigned Values	Strength of Announcement
All categories except for attendance at conference and superior IT management capability	0	Complementary investment absent
	1	Will implement or plan to implement in the future
	2	Made a contract or announced a contract to implement complementarities
	3	Currently being implemented
	4	Implemented in the past
	5	Indication of strong capability (e.g., award winner of complementarity)
Attendance at Conference	0	Absent
	1	Attended meeting
	2	Memberships
	3	Presentations
Superior IT Management Capability	0	Absent
	1	Present

Evidence of specific complementary investments was identified based on the search criteria in Tables 6.4 and 6.5. For each account, a value was then recorded for the complementary investment according to the coding rules specified in Table 6.6. After all data were collected, the values recorded for each complementary investment for each firm were aggregated, with higher values representing higher levels of investment.

6.3.1. Coding Reliability

Two trained readers coded the contents independently. Inter-coder reliability represents a level of agreement between coders. The cut-off value of the inter-coder reliability in content analysis is above 0.7 (Krippendorff, 1980). Following this cut-off value, the study sets a minimum of 0.7. If reliability of a specific variable is less than 0.7, the coders will meet and discuss the content to examine the disagreement. The inter-coder reliability will be reported in the next chapter.

6.4. Unit of analysis and Data Analysis

The unit of analysis is the firm. Since the research sample was limited to those firms that had invested in SCM or CRM, investment in artifactual capital was constant and therefore not included in the analytical model. Data analyses were conducted in two stages. First, factor analyses were used to confirm the remaining four forms of capital conceptualized – human, social, community, and structural – and to create factor scores to aggregate the individual assessments of these constructs. After the factor scores were obtained, hierarchical regression analysis using GLM (general linear model) was conducted.

Prior to the GLM analysis, a preliminary regression analysis was conducted to identify potential outliers. For samples larger than 80 observations, observations whose predicted values differ from their actual values by 3 or more standard deviations may be excluded (Hair et al., 1998a). The predicted value for the dependent variable for Dow Chemicals was noted to lie 7.6 standard deviations from its actual value. Given the study's sample size of 91 observations, this observation was considered to be an outlier and excluded from further analyses.

6.5. Summary of Research Methods

This chapter explicates research methods that include data sources, operationalizations, coding rules, and statistical analyses. As a research sample, SCM- and CRM-deployed firms will be used because the main objective of this study is to examine complementary investments and firm performance, and different roles of complementary investments rather than the focal investments. In order to explore

different roles of complementarities, additive and moderative roles will be tested using GLM. The research data will be solely from secondary data sources.

The next section will include coding reliabilities, factor analysis and research findings from hierarchical regression analyses in SCM and CRM contexts. Factor analyses using the oblique rotation method will be employed to extract different values of capital. Then this factor value will be used for hierarchical regression analyses. As noted, four forms of capital are used as additive, while the three forms of capabilities are used as moderating variables.

CHAPTER VII: ANALYSES AND RESULTS

The previous chapter dealt with the research design and the operationalization of the variables. The collected data are analyzed according to the proposed conceptual model. Before discussing the data analysis, coding reliability is provided, and then a factor analysis is conducted to extract factor scores for each construct. The statistical analyses and the discussions of the findings in the SCM and CRM contexts are followed.

7.1. SCM- and CRM-Deployed Firms and Coding Reliability[1]

SCM- and CRM-deployed firms are first identified in order to use them as a sample. The identified firms are attached in Tables A7.1, A7.2, and A7.3. Complementary investments are searched based on those firms and coded according to the coding rules.

Two trained coders coded the announcements independently. Two stages of coding procedures were applied. The first stage was to examine whether the two coders identified an announcement as the same complementary investment, and the second stage was to compare whether the strength of an announcement was the same.

The first stage of coding was over 99% across all announcements, except for the constructs for R&D and NPD (80%) and market collaboration and sharing information (90%). The low reliability of R&D and NPD was due to poor definitions. The new definition of NPD is a firm's investment in the process, hardware, or software that are designed to enhance new products, while that of R&D is a firm's R&D activities and new products that are produced as a result of R&D activities. Examples of R&D products are the introduction of new drugs or new skin care products to market. The low reliability of market collaboration and sharing information happened because the two coders did not

[1] Given the archival nature of this data set, other reports of reliability, i.e., of item stability or consistency, were irrelevant.

share the same understanding of the provided definition. While market collaboration refers to collaborative activities between or among firms in order to secure market in social capital, information sharing was a part of sharing culture measurements in authoritative rule. After the coders attained a shared understanding of the definitions coding, reliability was 99% for both issues.

The second coding reliability was related to the strength of an announcement. The coding rules are attached in Table 6.6. Coding reliabilities across SCM and CRM industry categories are above 90%. Overall, the coding reliability is very high because of clear coding directions. The coding reliability is shown in Table 7.1.

Table 7.1: SCM and CRM Reliabilities

Category	SCM	CRM
Automate	96.14%	92.46%
Informate	92.77%	94.60%
Transformate	94.89%	91.17%

Since the sources of data are Annual Reports, Press Releases, and news articles, the same exact announcement may possibly be coded more than once. In order to consider unique announcements, the announcements from Annual Reports and Press Releases were examined, and were deleted if announcements referred to the same investment. Thirty six (or 1.90%) out of the total 2615 announcements were deleted from the SCM data set. Twenty one (or 1.81%) out of the total 1560 announcements were removed from the CRM data set. However, since news articles are announced by a third party, rather than client firms, they represented high visibility of an announcement. Thus announcements from news articles were retained in the data set.

7.2. Factor Analysis of Forms of Capital

The operational definitions of the four forms of capital conceptualized were different across the two investments studied. Factor analyses were therefore used to confirm the anticipated structure of these variables and to generate factor scores that aggregated the individual assessments of these constructs. Factor analysis was performed using an extraction criterion of a minimum eigenvalues of 1 and oblique rotations. The oblique rotation accurately captures the complexity of the examined data. This rotation method is employed when "the ultimate goal of the factor analysis is to obtain several theoretically meaningful factors or constructs" (Hair et al., 1998b, pp. 110-111). On the other hand, the orthogonal rotation maximizes the variance explained by forcing uncorrelated variances into factors. Therefore it is preferable when "the goal of the research is to reduce the number of original variables, regardless of how meaningful the resulting factors may be" (Hair et al., 1998b, p. 110). In order to ensure construct validity, the oblique rotation is employed. Factor loadings are reported in Tables 7.2 and 7.3. The factor scores generated through these analyses were then used in the subsequent hierarchical regression analyses.

Table 7.2: Factor Loadings for SCM Investment

Items	Structural	Social	Community	Human
Cross-functional training	**.824**	.174	.138	.254
Decentralized decision-making	**.784**	.064	.242	-.167
Vendor managed inventory	.071	**.916**	.212	.001
Supplier vendor relationships	.207	**.893**	.339	.254
Data standardization	.311	.398	**.839**	.265
Support for information sharing	.145	.146	**.910**	.206
Conference attendance	.215	.326	**.908**	.136
General training	.333	.465	.489	**.630**
SCM-specific training	-.005	.038	.148	**.890**

As expected, Table 7.2 shows that structural capital for SCM investments is manifest in cross-functional training and decentralized decision-making. Social capital is

represented in vendor managed inventory and supplier vendor relationships. Community capital is evident in data standardization, support for information sharing, and SCM-related conference attendance. Finally, human capital is manifest in general training and SCM-specific training.

Table 7.3: Factor Loadings for CRM Investment

Items	Structural	Social	Community	Human
Cross-functional training	**.720**	.227	.213	.-.078
Decentralized decision-making	**.879**	.007	.063	.050
Customization	.207	**.653**	.185	.195
Market collaboration	.029	**.841**	.011	-.256
Data standardization	.476	.285	**.766**	-.234
Support for information sharing	.162	.094	**.829**	.196
Employee empowerment	.251	.003	**.697**	-.438
Conference attendance	.251	.453	.074	**-.806**
General IT training	-.077	-.130	.144	**-.848**

Again, as expected, Table 7.3 shows that structural capital for CRM investments is manifest in cross-functional training and decentralized decision-making. Social capital is represented in customization and market collaboration. Community capital is evident in data standardization, support for information sharing, and employee empowerment. In the case of CRM, human capital manifests in attendance at CRM conferences and in general IT training.

7.3. Data Analyses and Discussions of Research Findings

This section presents research analyses and findings for SCM investments. In the analysis, the industry strategic IT roles are excluded due to their high correlation with the firm size measurement. The analyses of these two variables appear in Tables A7.4, A7.5, and A7.6. GLM analyses with and without the size variable show that the industry effect is not an important predictor for EBITDA, which is one of the dependent variables. Since industry and size were highly related, including them both in the model generated multi-collinearity problems. An ANOVA for firm size across industry categories,

reported in Table A7.6, confirms this association. The analyses therefore included only the size variable as a statistical control, since there was greater variation in size than in industry.

The discussions of analyses are organized based on each dependent variable proposed in the Research Methods section. Within the discussion of each dependent variable, findings are discussed in the order of the control variable (firm size), the main effect variables (structural, social, and human capital), and the moderating variables (foundational, synergistic, and superior management IT capabilities).

7.3.1. SCM Analyses and Discussions

Table 7.4 shows a correlation matrix among the variables in the analyses. Descriptive statistics appears in Table A7.7.

Table 7.4: Correlation of the SCM Constructs

	Size	ST	Social	Comm.	Human	FD	SY	Mgt
Size	1							
ST	.292***	1						
Social	.389****	.169*	1					
Comm.	.332***	.237**	.281***	1				
Human	.275***	.091	.156	.206*	1			
FD	.261**	.232**	.239**	.469****	.154	1		
SY	.384****	.282***	.249***	.462****	.474****	.307***	1	
Mgt	.268***	.197**	.378****	.600****	.196*	.461****	.300***	1

*p<.1, ** p<.05, *** p<.01, **** p<.001
Legend: ST: Structural; Comm.: Community; FD: Foundational Capability; SY: Synergistic Capability; Mgt: Management Capability

7.3.1.1 Analyses and Discussions of SCM Operating Efficiency Variables

This section contains the discussions of operating efficiency measurements: Inventory Turnover, Net Cash Flow (NCF), Gross Profit (GP), and Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA). The year the dependent

variables was used is 2003. Detailed discussions of each analysis are provided in each section.

Inventory Turnover

Table 7.5 shows the hierarchical regression analysis on Inventory Turnover as a dependent variable.

Table 7.5: SCM Hierarchical Regression Model – Inventory Turnover

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
	t-value	t-value	t-value	t-value	t-value	t-value	t-value	t-value
Intercept	5.351****	4.832****	5.097****	4.548****	5.428****	5.120****	4.512****	3.964****
Size	.692	.807	.914	1.094	1.192	1.206	.804	.849
Structural		-.233	-.064	.018	.121	-.130	-.221	.256
Social		-.042	.097	-.223	.026	.091	.024	-.002
Community		-.588	.109	-.546	.180	-.259	-.354	-.596
Human		.119	.184	.783	1.110	1.131	.127	.330
FD			-1.801*	-1.903*				
ST * FD				.082				
SO * FD				.349				
CO * FD				.679				
HU * FD				-.696				
SY					-2.308**	-1.649*		
ST * SY						.204		
SO * SY						-.105		
CO * SY						.552		
HU * SY						-.392		
MC							-.244	-.178
ST * MC								-.502
SO * MC								-.014
CO * MC								.492
HU * MC								-.307
df	1, 88	5, 84	6, 83	10, 79	6, 83	10, 79	6, 83	10, 79
Adjusted R^2	-.006	-.048	-.021	-.056	.003	-.040	-.060	-.105
R^2 (F, p)	.005	.011 (.186, .967)	.048 (.699, .651)	.064 (.529, .865)	.071 (1.051, .399)	.077 (.659, .759)	.012 (.163, .986)	.019 (.153, .999)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Control, Complementarity, and Moderating Variables

All models are not significantly improved in Table 7.5. This may be because the benefits of inventory turnover from SCM deployment appear to accrue as a direct result of the artifactual capital. Therefore, the hypothesized complementarities don't seem to be required.

Net Cash Flow (NCF)

Table 7.6 shows the hierarchical regression analysis using NCF as a dependent variable. Table 7.6 includes the control, complementarity, and moderating variables.

Table 7.6: SCM Hierarchical Regression Model – Net Cash Flow

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
	t-value	t-value	t-value	t-value	t-value	t-value	t-value	t-value
Intercept	1.072	2.581***	1.954*	1.943*	.894	.585	1.427	1.643*
Size	4.867****	2.565***	2.529**	2.152**	2.327**	3.190***	2.696****	2.829***
Structural		3.755****	3.704****	-.693	3.124***	-1.337	3.660****	-.906
Social		-1.084	-1.103	-1.268	-1.426	1.461	-1.669*	.069
Community		3.668****	3.261***	4.060****	2.240**	.397	1.887*	1.938*
Human		2.600***	2.573**	.155	.445	-.101	2.557**	-.035
FD			.331	.703				
ST * FD				1.770*				
SO * FD				.285				
CO * FD				-2.882***				
HU * FD				1.438				
SY					4.819****	2.954***		
ST * SY						4.044****		
SO * SY						-2.926***		
CO * SY						2.640**		
HU * SY						1.108		
MC							2.206**	1.410
ST * MC								4.958****
SO * MC								-1.089
CO * MC								-1.086
HU * MC								4.564****
df	1, 87	5, 83	6, 82	10, 78	6, 82	10, 78	6, 82	10, 78
Adjusted R^2	.205	.442	.436	.499	.559	.660	.466	.637
R^2 (F, p)	.214 (23.69, .000)	.473 (14.92, .000)	.474 (12.32, .000)	.556 (9.78, .000)	.590 (19.63, .000)	.698 (18.07, .000)	.503 (13.82, .000)	.678 (16.44, .000)
ΔR^2 (F, p)		.2590 (7.25, .000)	.001 (.086, .770)	.083 (1.48, .204)	.117 (11.4, .001)	.108 (2.512, .048)	.03 (2.66, .107)	.175 (4.402, .003)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Control Variable

The firm size as a control variable shows a high correlation with the measurement of NCF. As provided in Table 6.1, since NCF includes cash dividends and capital expenditures, it seems that larger firms are highly likely to invest in capital, and provide higher levels of cash dividends.

Complementarity Variables

In Model 2, the addition of the four complementarity variables to Model 1 significantly improved the model fit (p=.000). The three complementarity variables are also highly significant although the social capital variable is not statistically significant. The structural capital variable significantly enhanced NCF. It has long been recognized that technology changes organizational structure whether it is centralized or decentralized. The type of change may depend on the nature of technology or how an organization uses technology. Complementarity scholars observed decentralized decision-making and cross-training in IT implementation in general (Brynjolfsson et al., 1997), and decentralized decision-making in SCM implementation in particular (Fan et al., 2003). Decentralized decision-making enables each division to optimize its decision regarding purchase, delivery, and inventory availability based on its own accumulated knowledge and expertise. With SCM it is especially important due to the amount of data it generated and the speed decisions required by highly dynamic environments. By optimizing each division's decision-making, firms can best use local knowledge and expertise. However, this decision structure often results in functional silos, which can result in the bullwhip effect (Lummus et al., 2003). Functional silos are especially problematic in SCM (IIE Solutions, 1999). Cross-functional training is a good way to

minimize functional silos (Brian, 1999). It facilitates communication across divisions and allows each division to understand other divisions' activities, and therefore enable the decentralized decisions to be coordinated. Further, cross-functional training improves the understanding of new products from other divisions, and can facilitate up-selling and cross-selling, as shown in Table A7.13. It in turn may lead to high levels of NCF.

Community capital is composed of *data standardization, support of sharing information,* and *SCM conferences*. Data standardization is a basis for creating work-related communities. Knowledge sharing software, such as eRoom and AskMe, is a good tool to connect community people and share their ideas. Since SCM use may be embedded in particular communities of practice (e.g., different firms utilize different functions more than others or adopt them differently in order to make those functions to fit their organizational purposes), sharing information through employee interactions and through a sharing culture is important for organizations to accrue value from SCM. Since firms have different product and sales strategies, as shown in Table A7.13, firms train their own employees, especially new employees. Previous research shows that sharing information, which leads to successful IT implementation, stems from interactions among employees (e.g., Lederer and Sethi, 1988). Attendance at SCM conferences or being a member of SCM conferences may inform the strategic use or emerging features of SCM within the community. Here, external connections are very important to creation of community capital. XML, a commonly accepted data standardization in the Chemical industry, connects community and informs members of cost effective ways of exchange and its benefits (*PR Newswire*, March 27, 2001). SCM conferences inform the importance of data standardization (http://www.supply-

chain.org/SER/2004/presentations/Kellam&Guardiola_SER04.pdf), and inform efficient uses of data standardization to increase NCF.

Human capital, measured by *General Employee Training* and *SCM-specific Employee Training,* is positively related to NCF. As previous scholars argued, users are those who can leverage the values of technical investments. In this context, users understand the strategic use of SCM in the business context and learn more about SCM functionalities through training as is shown in Table A7.13. The Appendix table also shows that the sample firms provided communication skills, and decision-making training, which are the portions of SCM-specific training. All these trainings facilitate sales, which directly contribute to NCF.

Moderating Variables

Models 3 and 4 show no significant improvement from Model 2 (p=.770, p=.204). Model 5 that includes synergistic capability as a main effect shows a significant improvement from Model 2, and the synergistic capability variable is also highly significant. This finding may be resulted from CRM's capability to provide information about accurate product demands directly to SCM, which could in turn free net cash. Model 6 presents the addition of the interaction effects of synergistic capability (measured by *CRM* and *NPD*) with the four capital variables. The model fit is marginally improved (p=.048) from Model 5, but the interactions are highly significant although the interaction with social capital is negative. The analysis suggests that decentralized decision-making contributes to NCF when SCM, CRM, and NPD are invested in together. As different functional areas deal with their own fast changing environments, the economic importance of decentralized decision-making is higher (Boland et al.,

1994). As decision-making is decentralized, the importance of coordination is also higher. Therefore, it is observed that those firms that invested in SCM and CRM together tend to have higher functional silos across divisions (Bartholomew, 2004), which diminishes economic values of these investments. In order to leverage the value from these investments, cross-functional training and teamwork are required in order to deliver products promptly and receive payments. Through this functional coordination, SCM can provide high levels of cash flow when it receives first hand customer order information from the CRM division regarding what to produce and order. Therefore, it is not surprising that the analysis shows a strong interaction effect between structural capital and synergistic capability in enhancing NCF.

The interaction between community capital and synergistic capital is also highly significant in enhancing NCF. As a number of functions increases, different communities may develop their own ways of performing work within the context. Here, as a knowledge transfer mechanism, cross-community communications [cross-functional training] may be required (Boland and Tenkasi, 1995), which is measured in this study as *support of sharing information* within an organization. Although each firm develops its own way of adopting technology according to its strategy, some firms are more successful than others. Therefore, SCM conferences provide best practice sessions that allow those successful firms to share their successful stories of SCM implementation or provide networking sessions that share information (http://www.crm-a.org/). These internal and external interactions are especially important when SCM environments change quickly because there are a many unpredictable exceptions. Therefore, it seems

that higher levels of investment in community and synergistic capability are highly related to NCF.

Unexpectedly, the interaction between social capital and synergistic capability are negatively, albeit marginally, related to NCF. Social capital is measured by *vendor managed inventory and supplier-vendor relationships*. It could be that firms had already invested in this capital and reaped the value when it was initially implemented. This may especially be true if vendor managed inventory has been performed by Quick Response (QR) for a long time. Thus, although it is necessary capital, after investment in social capital has reached a certain level, its value generation may be relatively constant.

Model 7 represents the analysis with management capability, but the model is not significantly improved from Model 2. Model 8 that includes management capability as moderating effects with the four capital variables is significantly improved from Model 7 ($p=.003$), and the interaction effects of IT management capability with structural and human capital are highly significant. It may be that the value extraction from the deployment of SCM requires structural changes, especially decentralized-decision making, and cross-functional training and teamwork. Successful organizational changes are possible when top managers see the value of SCM operation, and initiate appropriate organizational changes. In SCM, decentralized decision-making (Fan et al., 2003) and cross-functional training for coordination and information sharing appear to be important in increasing NCF.

Capable IT managers may understand how important employee training is in order to efficiently use SCM. The managers may also understand the importance of user training that is based on the firm's business strategy. Some firms' strategy could be

concentrating on profitable customers or new market development. Therefore, it seems that capable managers understand the importance of user training within the context of the firm's strategy, and enhance cash flow through this training.

Gross Profit (GP)

Table 7.7 shows the hierarchical regression analysis. The discussion of the analysis is based on the control, complementarity, and moderating variables.

Table 7.7: SCM Hierarchical Regression Model – Gross Profit

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
	t-value	t-value	t-value	t-value	t-value	t-value	t-value	t-value
Intercept	1.225	2.709***	2.539**	2.660**	.959	.845	1.638	2.230
Size	6.394****	3.998****	4.008****	3.398***	3.783****	4.657****	4.104****	4.502****
Structural		3.579****	3.598***	-.210	3.237***	-.841	3.549****	-.842
Social		-.748	-.702	-.873	-1.070	1.126	-1.249	-.197
Community		3.309***	3.261***	3.928****	1.800	.279	1.744	2.184**
Human		2.906***	2.910***	.645	.609	.017	2.877***	.283
FD			-.532	-.055				
ST * FD				1.142				
SO * FD				.191				
CO * FD				-2.850***				
HU * FD				1.115				
SY					5.656****	3.361***		
ST * SY						4.011****		
SO * SY						-2.260**		
CO * SY						2.097**		
HU * SY						1.276		
MC							1.937*	.771
ST * MC								5.455****
SO * MC								-.329
CO * MC								-1.368
HU * MC								4.727****
df	1, 90	5, 86	6, 85	10, 81	6, 85	10, 81	6, 85	10, 81
Adjusted R^2	.305	.496	.492	.531	.630	.700	.512	.680
R^2 (F, p)	.312 (40.89, .000)	.524 (18.95, .000)	.526 (15.70, .000)	.583 (11.31, .000)	.654 (26.81, .000)	.733 (22.23, .000)	.544 (16.92, .000)	.715 (20.32, .000)
ΔR^2 (F, p)		.212 (5.78, .000)	.002 (.178, .674)	.011 (1.07, .385)	.13 (13.30, .000)	.008 (1.84, .128)	.02 (1.82, .182)	.171 (4.435, .003)

*p<.1, ** p<.05, *** p<.01, **** p<.001. Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Control Variable

The control variable is highly significant. As a firm increases in size, GP also increases, suggesting that larger firms are much more likely to have more products and likely to have marketing capability, and hence, they are likely to sell a greater number of products than smaller firms. At the same time, larger firms are able to efficiently manage COGS which includes inventory costs and personnel expenses. The calculation of GP appears in Table 6.1.

Complementarity Variables

The three complementarity variables are highly significantly related to GP, while social capital is not statistically significant in enhancing GP. The inclusion of these variables significantly improved the model fit in Model 2 (p=.000). Structural capital (measured by *decentralized decision-making* and *cross-functional training*) may facilitate order management and order fulfillment by enabling firms to promptly react customer needs and improve sales performance by decreasing time-to-market and out-of-stocks (Langnau, 2002). Structural capital enables each functional area to leverage its expertise via information sharing across SCM functional areas. For example, sales and marketing operations should leverage each other's expertise in order to increase sales through cross-functional training (Donath, 2004). While marketers understand the importance of 4 P's of product, promotion, price, and place, they may not recognize the importance of probing customer needs and values, building relationships and communicating with customers, all of which can be learned from the salespeople (Donath, 2004). Therefore, through cross-functional training, this gap can be bridged and GP rises.

Community capital (measured by *data standardization, support of sharing information,* and *SCM conference*) may contribute to reducing disparate business processes and systems that can be derived from the proliferation of customer contact points and channels, and that can result in incompatible and disconnected views of customers (Chan, 2005). Service representatives deal with the same question by a customer by looking at the consolidated customer information, and may share knowledge to solve problems. Or SCM divisions may share information on forecasts of demand, marketing strategies, and new products, firms can increase the profitable products, which will increase GP. Community as a knowledge net is not limited to internal interactions, it also expands to include external networking (Boland and Tenkasi, 1995), which is measured by attending at SCM conferences or being a member of SCM conferences (conferences or professional organizations). As noted, SCM conferences offer best practice sessions, which enable the participants to share SCM methods for sales improvements and cost reduction.

Human capital, which includes users' SCM-specific and SCM non-specific training, is positively related to GP. Interpersonal skills, such as communication skills and flexibility, are very important, especially when it comes to customer service. In spite of the clique, the customer is not always right, but the customer does expect gracious service (Kent, 1991). Acknowledging a mistake and finding a workable solution resolve customer service situations more effectively than does trying to explain a company's side of the situation (Kent, 1991). As shown in Table A7.13, the sample firms provide training that is closely related to sales. In order enhance sales, Lucent Technology acknowledged the importance of sales forces training in improving

performance, and formed a strong link of communication between the HR team and the sales force (Anonymous, *Development and Learning in Organization*, 2005). Through training, the firm was able to increase sales and profit. This analysis is consistent with the finding in Model 2.

Moderating Variables

Models 3 and 4 that include foundational capability as a main effect and interaction effects do not show a significant improvement of the model fit (p=.674, p=.385, respectively). Model 5 that adds synergistic capability as a main effect shows a significant model improvement (p=.000), and the variable is also highly significant. This finding implies that CRM provides information about popular and profitable products to SCM, so that SCM can respond in order to increase sales, which is reflected in GP.

Model 6 that includes synergistic capability as moderating effects does not show a significant model improvement from Model 5, but if it is compared with Model 2, its improvement is highly significant (p=.001). This finding suggests that not only does CRM serve as improving GP, but also synergistic capability amplifies economic returns from the interactions with the capital variables. In Model 6, structural capital is especially critical in enhancing GP because when a firm invests in SCM, CRM, and NPD together, it is critical to decentralize decision authority to its functional areas in order to leverage local knowledge. As firms have diverse strategic objectives, such as cost reductions through SCM and increase sales through CRM, each business unit continues in its own silo without sharing knowledge or data with other business units (Hannon, 2004). Although all functional areas maximize their own performance, if they are not coordinated toward the firm's SCM strategy, these increases in performance may not lead

to an overall increase in value at the enterprise-level. Therefore, cross-functional training is especially critical. Through cross-functional training, SCM users are aware of customer information about product demands or problems (such as delivery problems or product defects) which may be located in CRM database. Prompt reactions to these problems may improve customer satisfaction and increase sales.

Data standardization, one element of community capital, is essential for transferring information across divisions and across applications. Previous scholars reported that SCM, CRM, NPD complement each other (Srivastava et al., 1999; Schrage, 2004). A connection of SCM to CRM also provides better visibility of demand, deliver time, and location of products (Hickey, 2004). SCM and CRM divisions are in a rapidly changing environment. In such an environment, users deal with new issues and problems whose answers may be easily obtained from those people in the same community. Since learning is situated within these communities-of-practice, users in the community may provide efficient advice. The analysis in Model 6 is consistent with this argument.

Models 7 and 8 show the results of including management capability as main and interaction effects respectively. The improved model fit is not statistically significant in Model 7 (p=.182), but Model 8 is highly significant (p=.003). The interaction effects between structural capital and management IT capability are highly significant. Top management is in a position to coordinate different functional areas (Donath, 2004). As discussed, SCM functional areas could be functional rivals that don't share information, but rather focus on maximizing their own interests (Fan et al., 2003). The profits of the SCM deployment are derived from a coordination of different functional areas. Here

managers' organizing vision regarding organizational structure and coordination appear to be critical in enhancing GP.

The interaction effect between the human capital and the management IT capability is highly significant. As discussed, an efficient use of SCM deployment requires changes in organizational structure. User training is especially beneficial when an organization changes its structure and redirects the focus of work (Youndt et al., 1996). In such a situation, training has a positive relationship with firm performance (Snell and Dean, 1992). Previous studies also show that training improves customer satisfaction (Pugh, 2002) and has a direct positive relationship with productivity (Yi et al., 2003). The sample firms also appear to provide diverse trainings in order to satisfy their customers (Table A7.13). The finding in Table 7.12 suggests that as management IT capability is higher, they seem to understand the importance of training and increase sales through training.

Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA)

Table 7.8 shows the analysis of EBITDA. The discussion of EBITDA is organized based on the control, the complementarity, and the moderating variables.

Table 7.8: SCM Hierarchical Regression Model –Earnings Before Interest, Taxes, Depreciation, and Amortization

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
	t-value	t-value	t-value	t-value	t-value	t-value	t-value	t-value
Intercept	1.187	2.666***	2.151**	2.257**	.879	.909	1.497	2.178**
Size	5.503****	3.185***	3.152***	2.652***	2.850***	3.769****	3.305***	3.503****
Structural		3.415****	3.371***	-.678	3.053***	-1.173	3.392***	-.832
Social		-1.075	-1.073	-1.276	-1.467	1.519	-1.649*	-.212
Community		3.649****	3.339***	4.256****	2.154**	.511	1.903*	2.356**
Human		3.071***	3.048***	.418	.740	-.079	3.055***	.091
FD			.097	.504				
ST * FD				1.536				
SO * FD				.397				
CO * FD				-3.115***				
HU * FD				1.545				
SY					5.815****	3.624****		
ST * SY						4.485****		
SO * SY						-3.200***		
CO * SY						2.508**		
HU * SY						1.658*		
MC							2.209**	1.209
ST * MC								5.414****
SO * MC								-.774
CO * MC								-1.475
HU * MC								5.352****
df	1, 90	5, 86	6, 85	10, 81	6, 85	10, 81	6, 85	10, 81
Adjusted R^2	.243	.464	.458	.521	.6112	.714	.487	.678
R^2 (F, p)	.252 (30.288, .000)	.494 (16.767, .000)	.494 (13.81, .000)	.574 (10.91, .000)	.638 (24.94, .000)	.745 (23.67, .000)	.521 (15.43, .000)	.714 (20.24, .000)
ΔR^2 (F, p)		.242 (6.86, .000)	.000 (.000, 1.0)	.080 (1.87, .123)	.144 (14.97, .000)	.103 (2.463, .051)	.027 (2.47, .120)	.193 (5.142, .000)

*p<.1, ** p<.05, *** p<.01, **** p<.001. Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Control Variable

Model 1 represents the analysis of the control variable. As the size of firm increases, earnings are also significantly increased. It may be because this calculation does not include capital expenditure in which large firms are likely to go through more frequent technological changes, which require high levels of capital expenditure. This calculation adds capital expenditure back into earnings, which makes it bigger for larger firms.

Complementarity Variables

The three complementarity variables (structural, community, and human capital) are highly significant in improving EBITDA. The addition of the four variables also significantly improved the model fit (p=.000). Structural capital, measured by *decentralized decision making* and *cross-functional training*, enables firms to leverage expertise to enhance earnings in a coordinated manner. Previous study shows that under uncertain conditions, decentralized decision-making performs much better than centralized one (Kim and Burton, 2002). Efficient decisions often require decision makers' intuition that may derive from experience in the specific area (MacCormack, 2001). Consumer tastes and needs evolve very rapidly, and co-evolve with new technologies that become available (MacCormack, 2001). Here decentralized decision enables each division to respond to the changing environment, which in turn relates to earnings. In order to improve efficiency, the decentralized decisions must be coordinated. If the purchasing department orders materials based on its own assessment, and if the manufacturing department orders its own materials based on its own forecast, it

may create the bullwhip effect. Efficient operation is a big contributor to increased EBITDA.

Community capital is also highly significant in enhancing EBITDA. Data standardization increases internal and external efficiency, which is one of the biggest portions of EBITDA. Its benefits are quantifiable when they are used strategically (Langnau, 2002). The benefits can streamline data management with the maintenance of consistent and accurate data (McInnis et al., 2004), which can be used for order management, order fulfillment and corporate management (Langnau, 2002). It also improves sales performance, by decreasing time-to-market and out-of-stocks, (Langnau, 2002), which also contributes to EBITDA. Through these connections, data standardization provides a basis for working communities. In a rapidly changing environment, a lot of problems and issues may not be anticipated (MacCormack, 2001). Different problems can emerge depending on the technology appropriation contexts. In such a case, employees may get more information from their peers than standardized manuals that may not specifically describe the problems. Recognizing these benefits, software producers now acknowledge this benefit and provide software that facilitates employee interactions such as eRoom (Kontzer and Foley, 2003), AskMe, or Logility's Voyager XPS. Externally, standardized data format facilitates knowledge flow across firms but within the community. Especially SCM conference attendants discuss the benefits and problems of SCM applications or emerging features.

Human capital is an important contributor for EBITDA. SCM-specific and SCM non-specific training is important for the users to understand the importance of accurate data management, demand prediction, and the correct use of SCM functionalities.

Especially since SCM generates huge quantities of data, the value of SCM will be significantly diminished if users don't have training regarding how to use SCM in the business context (Baker, 1999). It is also critical to train the users to enter data correctly. Although firms have huge databases, poor data quality results in firms using as little as 8% of the available data for demand forecasting (Bellinger, 2000). In spite of data quality issues, firms must still forecast demand. Without this, firm may miss target for customers up to 50%. Training improves firm sales. Therefore, it is not surprising that the sample firms train order entry skill and forecasting skills (Table A7.13).

Moderating Variables

Models 3 and 4 show the analyses that include manufacturing capability as a main effect and interaction effects. The increased variance explained is not statistically significant (p=.1.0, p=.123). Model 5 presents synergistic capability as a main effect, and the incremental variance explained and the parameter coefficient are highly significant (p=.000). CRM provides profitable customer information to SCM about those customers' preferences and changing trends. The availability of this information enables SCM to secure profitable materials and meet customers' demand, which is in turn reflected in the earnings.

Model 6 presents the interaction effects of synergistic capability. The model fit is significant (p=.051), as are the individual parameter estimates. The interaction effect of structural capital and synergistic capability is positively related. When SCM, CRM, and NPD are implemented together, decentralized decision-making may be an efficient organizational design because each functional area is dealing with very different business issues that require specialized knowledge. However, this decentralized information and

knowledge must be coordinated. The sample firms appear to choose cross-functional training and teamwork for the coordination. Through cross-functional training, different functions in SCM can assess customers' needs at all stages of the value chain (Mascarenhas et al., 2004). CRM provides continuous and immediate feedback on customer needs, complaints, or product defects to SCM. Timely information increased firms' profit among the SCM deployed firms (Hadley, 2004). Coordinated activities across SCM, CRM, and NPD that lead to high earnings are possible when employees share quality information in a timely manner. For this reason, those firms with higher levels of synergistic capability are likely to invest in cross-functional training and teamwork to coordinate these activities.

Community capital also significantly interacts with synergistic capability in enhancing EBITDA. Data standardization enables the users to share information and knowledge, which is a basis for common language. This capital is especially important when different functional areas are in rapidly changing environments as is the case in CRM and CRM.

The interaction between human capital and synergistic capability in Model 6 is marginally related to the earnings. As discussed, the profitability from a technology investment depends on human capital (Hall, 2003). Those firms that strive to increase performance from SCM and CRM deployments continuously invest in training. For that reason, the demand for SCM and CRM training is increasing (Sauer, 2001).

Unexpectedly, the interaction between social capital and synergistic capability is negative although it is marginal. As discussed, it might be that the value derived from inventory control is accrued when SCM was initially deployed. Firms may further invest

in this capital in order to reinforce connections with other firms or stay on up-to-date technology, which may not increase earnings.

The inclusion of management capability as a main effect in Model 7 does not improve the model fit from Model 2 (p=.120). The model fit of Model 8 that presents management capability as a moderating effect is significantly improved (p=.000). The profitability of SCM is not due solely to cost cutting; rather it is also due to managerial capability to change organizational structure and provide training to users that maximizes the value from the SCM deployment. It is a manager's capability to assess profitable inventories and separate them from low profit generating inventories. Securing profitable inventories and delivering those products to the customers increases a firm's earnings. Some inventories increase earning significantly, while some inventories do not contribute to a firm's earning although it is done by a cost efficient manner. (Byrnes, http://www.bettermanagement.com/library/library.aspx?libraryid=11938&pagenumber=2, 2005).

7.3.1.2. Analyses and Discussions of SCM Capital Efficiency Variables

Return on Asset (ROA) and Return on Investment (ROI) variables are chosen to explore how the deployment of SCM enhances firms' capital efficiency. The findings of these two profitability variables are shown in Tables 7.9 and 7.10.

ROA and ROI

Table 7.9: SCM Hierarchical Regression Model – ROA

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
	t-value	t-value	t-value	t-value	t-value	t-value	t-value
Intercept	1.130	1.096	.954	.758	.751	.330	.389
Structural	-.077	-.031	-.271	-.143	-.209	-.124	-.072
Social	-.121	-.079	-.098	-.150	.026	-.440	-.111
Community	-.077	.086	.010	-.198	-.223	-.721	.107
Human	-.204	-.182	-.333	-.344	-.232	-.244	.043
FD		-.410	-.459				
ST * FD			.288				
SO * FD			.195				
CO * FD			.050				
HU * FD			.323				
SY				.358	.249		
ST * SY					.159		
SO * SY					-.150		
CO * SY					.145		
HU * SY					-.021		
MC						1.185	1.510
ST * MC							-.293
SO * MC							-.488
CO * MC							-.515
HU * MC							-.754
df	4, 87	5, 86	9, 82	5, 86	9, 82	5, 86	9, 82
Adjusted R^2	-.045	-.055	-.102	-.055	-.106	-.040	-.076
R^2 (F, p)	.001 (.026, .99)	.003 (.054, .99)	.007 (.065, 1.0)	.003 (.046, .99)	.003 (.030, 1.0)	.017 (.302, .91)	.031 (.290, .98)

*p<.1, ** p<.05, *** p<.01, **** p<.001. Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Table 7.10: SCM Hierarchical Regression Model – ROI

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
	t-value	t-value	t-value	t-value	t-value	t-value	t-value
Intercept	2.775***	1.996**	2.016**	1.860*	1.927*	2.621***	2.758***
Structural	1.133	1.120	.467	.941	.977	1.148	.597
Social	.295	.292	.034	.220	.734	.426	-.107
Community	.334	.308	1.007	-.005	-.180	.568	1.255
Human	.435	.432	-.410	-.025	.155	.451	.089
FD		-.004	.085				
ST * FD			-.324				
SO * FD			.314				
CO * FD			-1.108				
HU * FD			.759				
SY				.899	1.104		
ST * SY					-.563		
SO * SY					-.891		
CO * SY					.430		
HU * SY					-.420	-.526	-.357
MC							-.001
ST * MC							.385
SO * MC							-1.113
CO * MC							.060
HU * MC							
df	4, 87	5, 86	9, 82	5, 86	9, 82	5, 86	9, 82
Adjusted R^2	-.019	-.030	-.054	-.021	-.054	-.027	-.060
R^2 (F, p)	.026 (.587, .67)	.026 (.464, .80)	.050 (.473, .86)	.035 (.63, .68)	.050 (.478, .86)	.029 (.521, .76)	.045 (.43, .92)

*p<.1, ** p<.05, *** p<.01, **** p<.001. Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Tables 7.9 and 7.10 show the analyses on ROA and ROI. Across the analyses, the models do not show that the three complementarity variables and three moderating variables are significant.

7.3.2. CRM Analyses and Discussions

The search for firms that had invested in CRM within the sampling frame selected yielded only 43 observations. This sample size was so small that statistical power was lacking when all three complementarity variables were included (Hair et al., 1998a). Given the sample size limitations of the CRM dataset, hypothesis testing was scaled back to only hypotheses pertaining to structural capital. This choice was made for a number of

reasons. First, organizational designs represent the investment that managers have the most direct control over. As noted before, community capital is largely beyond the control of managers. Even social capital depends on entities outside the organization and beyond management control. While human capital can be directly controlled via investments in training, such investments can prove expensive and impossible in the absence of sufficient slack. In contrast, managers can always focus on re-structuring the organization in the deployment of a new technology. Second, analysis of the SCM dataset indicated that structural capital was the form of capital that had the most consistent impact on performance. Finally, preliminary analyses of the CRM dataset – provided in Appendix 9-12 – revealed structural capital to be the most significant input for CRM too.

Table 7.11 shows the correlation matrix for the variables included in the analyses of the CRM dataset. Descriptive analysis appears in Table A7.8.

Table 7.11: Correlation among Constructs in the CRM Dataset

	Size	Structural	Foundational	Synergistic	Management
Size	1				
Structural	.251	1			
Foundational	.169	-.039	1		
Synergistic	.592****	.169	.387***	1	
Management	.287*	.372**	.215	.330***	1

*p<.1, ** p<.05, *** p<.01, **** p<.001

7.3.2.1. Analyses and Discussions of CRM Operational Efficiency Variables

This section of analyses includes operational efficiency variables, which are Sales per Employee, Gross Profit, Net Cash Flow, and EBITDA. The organization of each section is the same as the CRM discussions, which are in the order of the control, the complementarity (structural capital), and the moderating variables.

Sales per Employee

Table 7.12 shows the hierarchical regression analysis on Sales per Employee. As discussed above, this table does not include human, social and community capital, but Table A7.9 shows the analysis with the three complementarity variables.

7.12: CRM Hierarchical Regression Model – Sales per Employee

	Model 1	**Model 2**	**Model 3**	**Model 4**
	t-value	t-value	t-value	t-value
Intercept	16.227****	15.933****	16.456****	16.215****
Structural Capital	1.165	1.127	1.763	1.513
Structural * Foundational		-.162		
Structural * Synergistic			-1.517	
Structural * Management				-1.097
df	1, 35	2, 34	2, 34	2, 34
Adj. R^2	.110	-.019	.045	.016
R^2 (F, p)	.037 (1.356, .252)	.038 (.672, .517)	.098 (1.854, .172)	.070 (1.284, .290)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Complementarity and Moderating Variables

Table 7.12 does not have a firm size as a control variable, as firm size is measured by taking the log the number of employees and the total employees is also used as the denominator for Sales per Employee. Unexpectedly, the addition of structural capital and the interaction variables does not improve the model fits in Models 1, 2, 3, and 4. It seems that these insignificant findings are due to the small sample size.

Gross Profit (GP)

The analysis of GP is shown in Table 7.13, and the analysis of GP with all complementarity variables appears in Table A7.10. The discussions of the findings are categorized into the control, the complementarity variable, and the moderating variables.

7.13: CRM Hierarchical Regression Model – Gross Profit

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	t-value	t-value	t-value	t-value	t-value
Intercept	-3.148***	-2.686***	-2.544**	-2.608***	-2.829***
Size	4.880****	4.439****	4.245****	4.138****	4.540****
Structural Capital		2.630***	2.800***	2.599****	.329
Structural * Foundational			-.973		
Structural * Synergistic				.226	
Structural * Management					1.009
df	1, 36	2, 35	3, 34	3, 34	3, 34
Adj. R^2	.381	.469	.468	.454	.469
R^2 (F, p)	.398 (23.815, .000)	.497 (17.325, .000)	.511 (11.847, .000)	.498 (11.253, .000)	.513 (11.895, .000)
ΔR^2 (F, p)		.099 (3.846, .058)	.014 (.497, .485)	.001 (.035, .8526)	.016 (.569, .456)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Control, Complementarity, and Moderating Variables

Larger firms are more likely to have large GPs and sell more customized products than smaller firms. Also, large firms are likely to have economies of scale to reduce COGS. GP calculation appears in Table 6.1.

The addition of structural capital to Model 1 marginally improved the model fit (p=.058) in Model 2. Structural capital construct, measured by *decentralized decision-making* and *cross-functional training*, is positively and significantly related to GP. The interpretation of this finding is that when customer demands are fragmented, firms decentralized decision authority in order to respond quickly and efficiently to customer needs and improve customer relationships (Riel and Lievens, 2004). For example, the marketing department may initiate a marketing strategy, which the sales department must know about. Cross-functional training will provide opportunities to share information. Also cross-functional training and teamwork provide opportunities to share ideas across

divisions, which often results in new product ideas (Gordon, 2003). Therefore, cross-functional training can increase GP, and the finding in Model 2 appears to be consistent with this argument. The addition of foundational, synergistic, and management capabilities as moderating variables does not improve the model fit in Models 3, 4, and 5 (p=.485, .853, .456 respectively).

Net Cash Flow (NCF)

Table 7.14 shows the CRM hierarchical regression analysis on NCF without the social and human capital constructs. Table A7.11 presents the full model of three complementarity variables and the moderating effects with the foundational, synergistic, and IT management capabilities.

7.14: CRM Hierarchical Regression Model – Net Cash Flow

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	t-value	t-value	t-value	t-value	t-value
Intercept	-2.379**	-1.924*	-1.778*	-2.580**	-2.004**
Size	3.727****	3.260***	3.074***	3.846****	3.302***
Structural Capital		2.506**	2.631***	-1.253	.519
Structural * Foundational			-.853		
Structural * Synergistic				1.924*	
Structural * Management					.715
df	1, 33	2, 32	3, 31	3, 31	3, 31
Adj. R^2	.275	.375	.370	.424	.365
R^2 (F, p)	.296 (13.894, .001)	.412 (11.200, .000)	.425 (7.645, .001)	.475 (8.722, .000)	.421 (7.523, .001)
ΔR^2 (F, p)		.120 (4.364, .045)	.009 (.291, .594)	.059 (2.006, .166)	.005 (.161, .691)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Control, Complementarity, and Moderating Variable

Model 1 shows the significant finding of the control variable. Larger firms are much more likely to have higher levels of NCF than smaller ones. Since NCF is calculated before Capital Expenditure and Cash Dividends, and since large firms are

more likely to sell large quantities of products, it is intuitive to expect larger firms to have higher NCF.

Model 2 shows the inclusion of structural capital. Its model is improved (p=.045). Decentralized decision-making could maximize each division's cash flow. For example, the marketing department knows how to maximize sales, and the sales department has its own strategy to increase sales from their accumulated knowledge and expertise. However, cross-functional training or teamwork should be provided across customers' credit, sales, production, customer service department in order further increase cash flow (Atkinson, 2000). In some cases, credit is referred to as the sales prevention department because of its practice of coming up with reasons why sales cannot be made (Atkinson, 2000). However, through cross-training and teamwork, credit departments can be committed to sales and growth as are the production and sales departments by finding ways to continue to make sales and aggressively help to build business. The major divisions that are necessary to have cross-functional training and teamwork to increase cash flow are sales relationships, customer relationships, collection activities and deduction management (Atkinson, 2000). Therefore, it seems that structural capital appears to be highly significant in enhancing NCF. However, foundational, synergistic, and management capabilities as moderating variables do not improve model fits in Models 3, 4, and 5 (0594, .166, .691, respectively).

Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA)

Table 7.15 shows the analysis of EBITDA without the social and human capital constructs. Table A7.12 provides the analysis with the three complementarity variables.

Models 2 and 3 are significantly improved while Models 4 and 5 are not. The detailed discussions of Table 7.15 are provided below.

7.15: CRM Hierarchical Regression Model –
Earning Before Interest, Taxes, Depreciation and Amortization

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	t-value	t-value	t-value	t-value	t-value
Intercept	-2.848***	-2.372**	-2.240**	-2.824***	-2.375**
Size	4.422****	3.960****	3.777****	4.314****	3.928****
Structural Capital		2.623***	2.736***	-.848	.854
Structural * Foundational			-.847		
Structural * Synergistic				1.528	
Structural * Management					.395
Df	1, 36	2, 35	3, 34	3, 34	3, 34
Adj. R^2	.334	.427	.423	.449	.413
R^2 (F, p)	.352 (19.552, .000)	.458 (14.813, .000)	.470 (10.034, .000)	.493 (11.030, .000)	.461 (9.689, .000)
ΔR^2 (F, p)		.106 (4.15, .049)	.012 (.425, .519)	.035 (1.269, .268)	.003 (.105, .748)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Control, Complementarity, and Moderating Variable

Model 1 shows an analysis with the control variable. As a size of firm is bigger, the size of EBITDA is also larger. Since EBITDA is before Taxes, Interest, Depreciation, and Amortization, it is bigger with the firm size. Bigger firms are likely to pay higher taxes and to have higher levels of depreciation and amortization than smaller firms.

Model 2 shows the inclusion of structural capital variable into the model with the control variable. The model fit is significantly improved (p=.049). It seems that, as discussed, decentralized decision-making can optimize its own decision boundary. However, if each division does not have an understanding what other divisions need, it could create unused inventories or products that may not be popular in the marketing

department. In such a case, it will increase operating expenses, which is a big portion of the calculation of EBITDA. The model fits in Models 3, 4, and 5 do not show a significant improvement (.519, .268, .748, respectively).

7.3.2.2. Analyses and Discussions of CRM Capital Efficiency Variables

As with SCM, the capital efficiency measurement variables are ROA and ROI. Tables 7.16 and Table 7.17 show that these two measurements are not significant.

7.16: CRM Hierarchical Regression Model – ROA

	Model 1	**Model 2**	**Model 3**	**Model 4**
	t-value	t-value	t-value	t-value
Intercept	1.255	1.211	1.040	1.126
Structural Capital	-.298	-.155	-.737	-.572
Structural * Foundational		-.324		
Structural * Synergistic			.685	
Structural * Management				.492
df	1, 36	2, 35	2, 35	2, 35
Adj. R^2	-.025	-.051	-.041	-.047
R^2 (F, p)	.002 (.089, .767)	.005 (.096, .909)	.016 (.278, .759)	.009 (.164, .849)

7.17: CRM Hierarchical Regression Model – ROI

	Model 1	**Model 2**	**Model 3**	**Model 4**
	t-value	t-value	t-value	t-value
Intercept	4.355****	4.323****	3.989****	4.116****
Structural Capital	.434	.248	-.769	-.387
Structural * Foundational		.411		
Structural * Synergistic			.906	
Structural * Management				.663
df	1, 36	2, 35	2, 35	2, 35
Adj. R^2	-.022	-.047	-.028	-.039
R^2 (F, p)	.005 (.188, .667)	.010 (.176, .839)	.028 (.504, .608)	.018 (.312, .734)

*p<.1, ** p<.05, *** p<.01, **** p<.001

7.4. Summary of Analyses and Results

This chapter provided factor analyses and discussions of the hierarchical regression analyses. Factor analysis using the oblique rotation method is employed

because it captures underlying theoretical constructs. As expected, the factor analysis identified four forms of capital. Using these factor scores, hierarchical regression analyses using GLM are performed. While the complementary investments are highly and positively related to the operational efficiency variables, capital efficiency variables are not related to complementary investments. It might be that capital efficiency variables are more distant than the operational variables to measure the economic effects of SCM and CRM.

CHAPTER VIII: DISCUSSION OF FINDINGS

The previous chapter reported on the results of the statistical analyses of this study. This chapter considers the findings against the theoretical development and hypotheses. First, it reviews the factor analyses and their congruence with the forms of capital postulated earlier. It then considers the effects of complementary investments relative to SCM and CRM deployments on firms' operational and capital efficiencies. Next, a couple of significant implications for practice and research are noted. The chapter finishes with a discussion of the limitation of this study and suggests future research directions.

8.1. Forms of Organizational Capital

The factor analysis of both the SCM and CRM datasets, summarized in Table 8.1, revealed a capital structure consistent with the 4-capital model articulated earlier. The relative robustness of the structure of organizational capital, as evident in the factor analyses, is notable. It highlights the salience of the two additional forms of capital identified in this research. Prior literature has considered the essential role of human and structural capital in the deployment of IT investments, albeit in a piecemeal fashion (e.g., Adler, 1988). This research highlights the distinct organizational practices that appear to aggregate together into human and structural capital. It also focuses attention on social and community capital, which have hitherto not been as clearly recognized within the IT impacts literature. Furthermore, even the organizational literature has not distinguished between social and community capital. In recognizing this distinction, this paper highlights the distinct role that organizations play in forging investment-specific

relationships versus providing support for the emergent relationships initiated by their employees.

Table 8.1: The Structure of Organizational Capital

Form of Capital	SCM Indicators	CRM Indicators
Structural Capital	▪ Cross-functional training ▪ Decentralized decision-making	▪ Cross-functional training ▪ Decentralized decision-making
Social Capital	▪ Vendor managed inventory ▪ Supplier vendor relationships	▪ Customization ▪ Market collaboration
Community Capital	▪ Data standardization ▪ Support for information sharing ▪ SCM-conference attendance	▪ Data standardization ▪ Support for information sharing ▪ Employee empowerment
Human Capital	▪ General IT training ▪ SCM-specific training	▪ General IT training ▪ CRM-conference attendance

8.1.1. The Consistent Nature of Structural Capital

Across both applications, structural capital was reflected in cross-functional training and decentralized decision-making. The apparent association of these two organizational practices is an important insight, highlighting their likely need to accompany each other – at least in firms that have invested in complex technologies such as SCM and CRM. Whether these two practices are critical to the deployment of all technologies, are essential only to complex technologies, or are specific to CRM and SCM needs to be ascertained with further research.

8.1.2. The Investment-Specific Nature of Human, Social, and Community Capital

The constitution of social, community, and human capital differed in anticipated ways across the two technological investments. Being oriented toward the supply-side of the value-chain, social capital was expected to be reflected in a firm's relationships with its vendors. In contrast, investments in CRM are directed toward enhancing the customer-side of the value-chain. Hence, the social capital expected here were

relationships that are forged directly with customers through customization or with other firms that enable market expansions, development of new customer segments, or exploration of market potential. The data supported these expectations.

Community capital was expected to be constituted by support for information sharing and data standardization across both applications. Communities-of-practice enable knowledge transfer and learning within and between organizations (Boland and Tenkasi, 1995). While organizations cannot initiate such communities, they can facilitate their functioning. This can be accomplished by providing employees with access to collaboration technologies that support information sharing and by providing a standardized data architecture that enables data integration.

In addition, attendance by employees at SCM conferences provides opportunities for them to develop personalized relationships with suppliers that facilitate knowledge transfer across organizational boundaries. In other words, by supporting employees' attendance at conferences, employers provide community bridges than enhance learning and knowledge diffusion. With regard to CRM, exchange of customer-based information is insufficient in enhancing customer satisfaction. Effective deployment entails empowering employees to be responsive to customer needs.

As anticipated based on prior research, human capital is manifest in general IT training across both technologies. Additionally, it is associated with exposure to application-specific knowledge. For SCM, this appears to be effected via formal training; for CRM, through informal exposure during attendance at conferences. The emergence of CRM has been more recent than supply-side enterprise systems (as will be apparent from Table A7.1 in the Appendix). At early stages of diffusion, individuals tend to rely

more on informal sources for learning about the technology than on formal sources (Rogers, 1995).

8.2. Understanding the Impacts of Investments that Complement SCM

Table 8.2 summarizes the SCM findings. Notably, none of the investments studied had a significant impact on capital efficiency (ROA, ROI). This will be discussed later. Notably too, none of the investments studied had a significant impact on inventory turnover. Each of the capital and capability constructs is now considered in terms of their impacts on other operational efficiency metrics. Later, we will consider why the impacts on inventory turnover and capital efficiency measurements were found to be insignificant.

Table 8.2: Summary of Hypotheses – SCM Analyses

Constructs	Hypotheses	Operational efficiency	Capital efficiency
Structural capital	**H1**: Investments in salient structural capital will increment the performance of firms that have invested in the focal IT	Supported*	Not supported
Social capital	**H2**: Investments in salient social capital will increment the performance of firms that have invested in the focal IT	Not supported	Not supported
Community capital	**H3**: Investments mobilizing salient community capital will increment the performance of firms that have invested in the focal IT	Supported*	Not supported
Human capital	**H4**: Investments mobilizing salient human capital will increment the performance of firms that have invested in the focal IT	Supported*	Not supported
Foundational capability	**H5**: Investments in foundational capabilities will moderate the payoff from investment-specific capital	Not supported	Not supported
Synergistic capability	**H6**: Investments in synergistic complementary investments will moderate the payoff from investment-specific capital	Supported for all but social capital*	Not supported
Management capability	**H7**: The presence of superior management capability will moderate the payoff from investment-specific capital.	Partially supported	Not supported

*for Net Cash Flow, Gross Profit, and EBITDA, but not for Inventory Turnover

8.2.1. SCM: Investment Specific Capability

Structural capital had a consistently significant impact on all operating efficiency variables, providing clear support for the importance of organizational practices of decentralization and cross-functional training in eliciting value from firms' investments in SCM. The role of structural capital is considered further below.

Unexpectedly, social capital was not found to contribute significantly to operational efficiencies. It could be a couple of reasons. First, since social capital is measured by vendor-managed inventory and supplier-vendor relations, when the focal firm contracts with a vendor, the focal firm might immediately experience reduced inventory levels, warehousing capacity, and associated personnel. These benefits would then be reflected in net cash flow improvements at the time of contracting. However, as time goes on, the incremental economic benefits may not be large enough to be captured in subsequent financial statements. Second, the economic benefits of social capital largely depend on the supplier – social capital is a function not only of the relationship, but also of the resources held by one's network ties. Thus, the focal firm is likely to garner economic benefits from its supplier relationships only if the supplier has the capabilities to enhance inventory management. Furthermore, a supplier that performs well for the focal firm is likely to be a preferred supplier for other firms too. Therefore, the supplier's resources are likely to be shared by other firms, minimizing the advantages that accrue to the focal firm. Third, the apparent inability of social capital to contribute to operating efficiencies may also be due to the re-distribution of those efficiencies to the supplier. Further research is required to ascertain whether the payoff from social capital is indeed a one-shot occurrence or whether the benefits are appropriated by the supplier.

Community capital was found to contribute significantly to all operational efficiency variables. This insight is particularly important because the community capital construct has not been incorporated into IT-based performance research. The significance of this effect may be because employees tend to rely on their peers for information (Cross et al., 2001). Through the "narrating" that occurs in communities-of-practice, employees are able to make sense of SCM use as a whole and understand specialized SCM use across different divisions and to develop the "common knowledge", which in turn facilitate knowledge sharing (Boland and Tenkasi, 1995).

While the role of human capital as a complement to IT investments has long been considered in research on IT impacts, it has not previously been empirically tested in the SCM context. As discussed, training in SCM was measured by SCM-specific and general training. In other words, SCM-specific training imparts 'know how' and 'know what' about SCM technology and functionalities, while general training facilitates coordination across the specialized functions of the firm. Consistent with the previous findings on IT-based firm performance, human capital was found to have a significant positive effect on all operational efficiency variables.

8.2.2. SCM: Investment-Related Capabilities

A synergistic capability with regard to SCM was considered to be CRM. The effect of this synergistic capability was found to moderate the effects of the structural, community, and human capital across all operating efficiency variables, except inventory turnover. In other words, the presence of a strong CRM capability was found to amplify the benefits of organizational practices that enhanced the performance of firms that invested in SCM.

Notably, the otherwise insignificant effects of social capital were often negative in the presence of CRM. Specifically, the effects on net cash flow and EBITDA were significantly negative; the effect on gross profit, while negative, was insignificant. A possible explanation for this finding is that social capital in the SCM context marked a level of firm dependence on its vendors. Such dependence likely curtailed firms' ability to react to customer demands necessitating supply-side flows that were not designed when inventory management was outsourced to the vendor. Thus, social capital prevented firms from reaping the benefits of their investments in CRM via speedy response to customers.

The proposed amplification of the benefits of the capital investments by management capability was only partially supported. Specifically, management capability amplified the benefits of structural and human capital, but not of community and social capital. These findings are intuitive, suggesting that a strong management capability is required to mobilize structural and human capital, though not community capital. This is entirely consistent with the communities-of-practice literature that suggests that while managers can support or kill such communities, managers can actually do little to mobilize value from them (Orr, 1990). In contrast, organizational structural and human capital initiatives require visionary management to match the initiatives to the requirements and opportunities of the technology being deployed. Given our failure to note direct effects of social capital on operational efficiencies, probably due to its one-time benefit or re-distribution to the supplier, it is not entirely surprising that superior management was not able to elicit any value from this form of capital.

Unexpectedly, foundational capabilities were not found to amplify the benefits of the capital investments – except weakly in the case of the effect of structural capital on net cash flow. An explanation could be that since this capability is required for the deployment of SCM, all SCM-deploying firms may have similar capabilities. In other words, the low variance in investments in foundational capabilities – as apparent in Appendix 7.7 – precluded us from observing an effect of this investment. A consistent finding with regard to foundational capabilities though is an apparently negative effect on the benefits that accrue from community capital. It is surprising that the SCM foundational capability, i.e., manufacturing capability, failed to amplify the benefits of structural, social, and human capital. The *negative* effect on the benefits from community capital is even more surprising. A strong forecasting ability, together with flexible production capabilities, should certainly augment the benefits of informal knowledge exchanges by enabling quick response to environmental changes. Perhaps if the emergent communities were strongly affiliated with the supplier though, the communities might have worked against the interests of the focal firm, an often-noted downside of inter-organizational communities-of-practice (Wenger, McDermott, and Snyder, 2002). An alternative explanation is that the upgrade of manufacturing capabilities requires firms to reorganize organizational structures and work practices. These changes may disrupt existing communities-of-practice (Orr, 1990). In addition to being disruptive, frequent reassignment of employees may create employee resistance toward management that is perceived to view labor as a commodity that may be reorganized to suit firms' needs (Orr, 1990). These impacts warrant further investigation in future research.

8.3. Understanding the Impacts of Investments that Complement CRM

Table 8.3 summarizes the research findings related to CRM investments. Since the CRM dataset was too small to test all the hypotheses, some appear as 'Not tested."

Table 8.3: Summary of Hypotheses – CRM Analyses

Constructs	Hypotheses	Operational efficiency	Capital efficiency
Structural capital	**H1**: Investments in salient structural capital will increment the performance of firms that have invested in the focal IT	Supported*	Not supported
Social capital	**H2**: Investments in salient social capital will increment the performance of firms that have invested in the focal IT	Not tested	Not tested
Community capital	**H3**: Investments mobilizing salient community capital will increment the performance of firms that have invested in the focal IT	Not tested	Not tested
Human capital	**H4**: Investments mobilizing salient human capital will increment the performance of firms that have invested in the focal IT	Not tested	Not tested
Foundational capability	**H5**: Investments in foundational capabilities will moderate the payoff from investment-specific capital	Not supported	Not supported
Synergistic capability	**H6**: Investments in synergistic complementary investments will moderate the payoff from investment-specific capital	Not supported	Not supported
Management capability	**H7**: The presence of superior management capability will moderate the payoff from investment-specific capital.	Not supported	Not supported

*for Net Cash Flow, Gross Profit, and EBITDA, but not for Sales per Employee

8.3.1. CRM: Investment-Specific Capability

As noted earlier, due to sample size limitations, structural capital was the only form of capital included in the analysis of the CRM dataset. As with the SCM dataset, positive impacts of structural capital were observed for all operational efficiencies but sales per employee - the metric believed to be most closely impacted by investments in CRM. We consider why this might have been the case later. Notably too, no effects were observed on the capital efficiency variables within this dataset either.

The effects of structural capital were consistently noted with regard to gross profit, net cash flow, and EBITDA. As expected, cross-functional training and decentralized decision-making thus appear to be critical in enhancing the performance of firms that have invested in CRM. This finding is consistent with the KBV: firms "know" how to do things and such knowing is embedded in their rules and procedures. Thus, the higher-performing firms among those that have deployed CRM appear to have mobilized local knowledge into organizational knowing through decentralized decision-making and cross-functional training.

8.3.2. CRM: Investment-Related Capabilities

The amplifying effects of foundational, managerial, and synergistic capabilities were not clearly visible within the CRM dataset. The benefits of structural capital in terms of net cash flow were marginally augmented by synergistic capabilities. However, none of the other interaction terms were found to be significant. Given the limited sample size, these effects are simply inconclusive though. Extending the dataset to include CRM deployments in more recent years is necessary in order to provide further insights into the amplifying effects of CRM-related capabilities.

8.4. Inventory Turnovers and Sales per Employee

These dependent variables were chosen for their anticipated proximity to the focal IT investments being studied. Since SCM is targets supply-side efficiencies, complements to SCM investments were expected to increase inventory turnovers among firms that had invested in SCM. Similarly, since CRM targets customer-side enhancements, complements to CRM investments were expected to increase sales per employee. However, these most proximate dependent variables were not found to be

significantly impacted by any of the individual capital investments or capabilities. This is possibly because the direct effects of SCM and CRM on these variables have an overwhelming impact on these dependent variables. However, this possibility could not be tested within the current design. Follow-up analyses will be conducted, comparing the firms in these SCM and CRM datasets with comparable samples of firms in the same value-chain that did not invest in these technologies.

8.5. The Critical Role of Structural Capital

It was intriguing to note the salience of structural capital as a complementary investment across both SCM and CRM technologies. Structural capital was examined here in terms of decentralization and cross-functional training. Clearly, it seems important that the deployment of complex technologies such as SCM and CRM be accompanied by organizational designs that are congruent with the technologies in order to reap value from the technology (Trist, 1981). In the practitioner literature, structural capital is believed to be a critical type of organizational investment for two reasons (e.g., Stewart, 1999). First, it is directly within the control of managers and, as such, enables more rapid organizational alignment with the needs of the moment. Second, it also allows organizations to harness other types of capital – specifically human and social – and to direct them toward the accomplishment of organizational ends. To a great extent, this research validates these positions.

8.6. The Critical Role of Synergistic Capabilities

Of the three capabilities explored here – foundational, managerial, and synergistic – synergistic capabilities appeared to have the greatest salience. The amplifying role of

synergistic investments in CRM were quite clear among SCM investors and also visible – though less so – in SCM investments among CRM investors.

8.7. Operating vs. Capital Efficiency Measurements from the CRM dataset

The research model explained a significant portion of the variance in the operating efficiency variables across both SCM and CRM datasets. However, parallel impacts were not noted vis-à-vis capital efficiency variables. This is probably because operating efficiency variables are more proximate to technological deployments, while many other factors can intercede in the capital efficiency of a firm.

These findings are quite consistent with those of earlier research (Mukhopadhyay, et al., 1995; Lee et al., 1999). Yet, it is essential that future research trace the nature of performance losses between productivity and profitability metrics to permit a better understanding of the specific constituents that ultimately benefit from firms' technological investments. Such an analysis of the re-distribution of the benefits of technological investments over time would enable firms to assess the long-term payoff from technological investments. Such an analysis would need to track whether, for example, transferring the benefits of inventory efficiencies to the customer pays off in the long term in customer loyalty.

8.8. Contributions of/to The Knowledge-Based View

The KBV considers the central role of organizations – and their distinctive capability over other economic forms – to be coordinating and integrating individual knowledge. From this perspective, it is not what the individuals in the organization know that confers competitiveness to a firm, but rather how that individual knowledge is brought together. The findings of this research support this premise. Instead of human

capital, which has most typically been the focus of the production-economics-based IT impacts studies, the resource stream most critical to firm productivity was found to be structural capital. In other words, the ability of firms to enact appropriate procedural rules and routines, specifically in terms of decentralization and cross-functional training, was found to enhance the performance of firms that had adopted complex technologies. These formal rules and routines are integral to the integration of knowledge across the organization. However, the less formal integrative mechanism – i.e., organizational support for communities of practice – was not found to significantly impact the performance of firms that had deployed either SCM or CRM. This finding is not inconsistent with the communities-of-practice literature though that suggests that the benefits from such communities are uncertain and, when they occur, are disbursed to constituents outside the organization just as frequently as they accrue to the organization itself (Stewart, 1999).

The third resource stream investigated – i.e., social capital – was not found to provide significant benefits to firms that had deployed SCM or CRM. This contradicts recent efforts by KBV theorists – and the associated RBV literature – to integrate the body of social networks findings into these perspectives (Kogut and Zander, 1992 Instead, this research suggests that under certain conditions, tight coupling with external entities can actually detract from the performance of firms deploying complex technologies. While social capital may indeed be beneficial in other terms, e.g., social capital was found to have a significant impact on innovation (Ahuja, 2000), the findings of this research largely spotlight structural capital as *the* means for coordinating and integrating organizational knowledge.

Another critical insight offered by KBV to this study of organizational impacts of IT investments was in regard to the role of capabilities. In contrast to the production-economics-based literature, this study conceptualized some investments as capabilities rather than as resource streams. The role of such capabilities was proposed to be multiplicative, rather than simply additive. Unfortunately, due largely to sample size limitations, the findings with regard to capabilities are less clear. Still, the findings with regard to managerial and synergistic capabilities provide some support for this perspective. They suggest the salience of overall managerial vision – and the vision to develop portfolios of technology-based capabilities – in reaping the benefits of IT investments.

CHAPTER IX: CONCLUSIONS

The previous chapter discussed the findings related to the impacts of firms' investments in SCM and CRM. It highlighted the variables critical to the performance of firms that had invested in complex technologies, i.e., SCM and CRM. This chapter briefly revisits the main research question, the contributions of this study to the academic community, its implications for practitioners. It then considers the limitations of this study and suggests directions for future study.

9.1. The Research Question Re-visited

The research question that was the focus of this study was: *what is the effect of complementary investments in the relationship between IT investments and firm performance?* Seven hypotheses were developed to address this question. As noted in the previous chapter, the findings supported most of the hypotheses in terms of operational efficiencies that accrued to investors in SCM. Impacts in terms of capital efficiencies were notably absent. Sample size limitations, while reinforcing some of the findings from the SCM dataset, precluded a clear perspective of salient inputs and moderators of firm performance within the CRM dataset.

9.2. Contributions of this Research

This study identified organizational elements that complement IT investments, focusing particularly on investments in SCM and CRM. Although the concept of complementarity is not new, previous studies have lacked clear construct boundaries and an overarching theoretical lens. Based on production function economics, the impacts of complementary investments have been viewed as purely additive. Employing KBV instead, this study identified established boundaries around the complementarity concept,

identifying several distinct complementarity constructs that play disparate roles in the mobilization of value from IT-based investments. Specifically, human, social, community, and structural capital were conceptualized as additive inputs, whose contribution to firm performance was suggested to be contingent upon the firm's foundational, managerial, and synergistic capabilities. Operationalizing this model might have proved to be a highly complex undertaking, but for a methodological approach that is unusual to these studies. These insights gleaned from the research model and findings and from the methodology are discussed further below.

9.2.1. Additive versus Multiplicative Complementarities

A novel contribution of this research to the literature on complementarities in IT impacts on firm performance was to point out the differences in the nature of the impacts of complementarities. Specifically, resource streams were conceptualized in terms of forms of capital and were proposed to have additive effects on firm performance. In contrast, knowledge assets that had already been consolidated into organizational capabilities were proposed to amplify the effects of the resource streams. The results of this study provide some support for these different roles of complementarities. Yet, the amplifying role of consolidated capabilities was noted largely in terms of synergistic capabilities and was equivocal at best with regard to foundational and managerial capabilities. Nonetheless, the disparate roles of IT complementarities clearly merit further investigation.

9.2.2. Methodological Contribution

Prior event study-based research on IT impacts has considered the technology deployed as an independent variable that directly and incrementally impacts firm

performance, in addition to a variety of other variables. Such a design does not truly permit the assessment of "complementary" effects of firms' co-investments in associated technologies and organizational practices. Rather, it enables the researcher to assess at most the incremental contribution of each investment to firm performance.

In contrast, this study isolated firms that had invested in SCM and CRM. Rather than considering the value of the technological investment, per se, it the explored the effects of various complementarities. By holding constant firms' technological investment, this design enabled a focus on firms' capability to leverage value from IT through complementary investments.

9.3. Implications for Practitioners

This study provides insights on leveraging value from SCM and CRM through complementary investments. Top managers often imitate other firm's successful IT deployments and question value extractions from the same IT investment. This study suggests that in order to derive value from an IT investment, the firm must make complementary investments. In this specific study, structural, community, and human capitals are found to be important complementary investments in enhancing operational efficiency. Although managers cannot control community capital, they still can support this capital by providing sharing software and facilitating a sharing culture. Also, synergistic and management capabilities are important moderating variables. The impacts of synergistic capability on firm performance were found to be higher than those of other capabilities. It is important for top managers who have already deployed SCM but have not deployed CRM to understand that potential economic benefits of having both the technologies.

9.4. Limitations and Suggestions for Future Research

Collecting data solely from a secondary data source has some limitations. First, it is sometimes difficult to assess a specific investment that is directly related to the focal investment. For example, suppose a firm provides IT training. Unless the announcement specifically indicates the training is for SCM or CRM, there is no way to verify the objective of the training. Subsequently, such training is categorized as general IT training rather than SCM- or CRM-specific IT training.

Another limitation of using secondary data sources is that if the data sources do not have information about a specific complementary investment, it is treated as 'no investment' even when a firm actually made an investment. For example, if a firm trained its SCM or CRM users in order to improve the economic return from these investments, but this information is not available in the secondary data sources, there is no way to include such training in the analysis.

Third, the CRM data sample is too small to identify significant variables and capture underlying patterns of the complementarity variables. This is due, in part, recentness of most CRM implementations, as shown in Tables A7.1. This problem cannot be fixed although other research methods (e.g., primary data collection method) are employed. In order to analyze and examine the contributions of the complementarity investments to firm performance, it is imperative to collect more data one or two years later.

Fourth, IT strategic role is in the research model but not in the analyses. As shown in Tables A7.4, A7.5, and A7.6, this control variable has high multi-collinearity with the firm size variable, and is not highly significant without the size variable. Given

the small sample size, we removed this variable from the analyses. However, since IT strategic role has been found to be correlated across different industry categories, this variable should be included in future research.

Sixth, the age of firms' SCM and CRM investments should be included in the model. The time element of SCM and CRM was originally included in the model, but was not found to be significant. This is probably because complementary investments are accumulated over time; thus, increased levels of complementary investments reflect an older focal investment. Thus, the time element was already accounted for indirectly in the model. Due to the constrained sample size and the apparent insignificance of the time variable, it was dropped from subsequent analyses.

Seventh, it is plausible that high-performing firms attract a larger proportion of awards because they are more visible. Thus, the use of awards as a proxy for management capability might pose a confound with the dependent variable.

Lastly, the effects of human capital on firm performance have been clearly established in prior research, but the findings were less consistent in this research. This is an area that requires further research in the future. In order for a capability to be effective, firms need a trained workforce to implement the firm's vision. This might explain why the interaction effect of human capital and management capability appear to be significant. However, it is also possible that human capital enables the development of other forms of capital. Further research is therefore necessary to understand the potential interrelationships among the forms of capital.

In future research, researchers studying the complementarity phenomenon in IT investments may use these constructs and compare across small and large organizations.

Often small organizations do not have resources to invest in the necessary complementarities, or they realized that the investment will not be payoff due to economies of scale. Therefore, it is worthwhile to explore how different firm sizes play out in terms of investing in complementarities and their economic value from the investments.

Second, different data sources may provide different views of the impacts of complementary investments on firm performance. For example, an Annual Report includes announcements by focal firms following the guidance given by government. Press Releases are from either/both a focal firm or/and vendors while news articles are from an independent third party. This study comprehensively included all these three sources but used only unique announcements. Since previous studies that used secondary data sources tended to adopt one of these, it is valuable to examine if there is any systematic differences across the sources of data employed and firm performance measured. As per agency theory, focal firms may want to announce investments that can impact Wall Street or the shareholders, while the vendors may want to send messages through the announcements to other firms or Wall Street about their successful stories to increase the visibility of their products. However, news articles are considered to be an independent source or neutral to vendors or focal firms. If there is a relationship between sources of announcements and firm performance, such findings may provide valuable insights on the use and the selection of secondary data sources.

Appendices

Table A7.1: Deployed Years of SCM and CRM

Year Deployed	SCM		CRM	
	Number of Firms	Percentage	Number of Firms	Percentage
1994	3	3%		
1995	8	7%		
1996	7	6%		
1997	10	9%	1	2%
1998	11	10%	1	2%
1999	14	13%	11	26%
2000	25	23%	7	16%
2001	13	12%	11	26%
2002	13	12%	9	21%
2003	7	6%	3	7%
Total	**111**	**100%**	**43**	**100%**

Table A7.2: SCM Sample Firms by SIC Code

	Household Products (1)	Diversified Chemicals (2)	Agricultural Products (3)	Fertilizer & Agricultural Chemicals (4)	Packaged Food (5)	Food Retail (6)	Drug Retail (7)	Pharmaceuticals (8)
1	Colgate-Palmolive Co	BASF Ag	Archer-Daniels-Midland Co	Agrium Inc	Aurora Foods Inc*	7-Eleven Inc	CVS Corp	Abbott Laboratories
2	Dial Corporation*	BAYER Ag	Bunge Ltd	Eco Soil Systems Inc*	Calavo Growers Inc	Albertsons Inc	Duane Reade Inc*	Able Laboratories Inc
3	Energizer Holdings Inc	Borden Chemical Inc	Cenex Harvest States*	Imc Global Inc-Pro Forma*	Campbell Soup Co	Kroger Co	Longs Drug Stores Inc	Akorn Inc
4	Kimberly-Clark Corp	Cabot Corp	Central Garden & Pet Co*	Lesco Inc	Conagra Foods Inc	Pantry Inc*	Phar-Mor Inc*	Allergan Inc
5	Procter & Gamble Co	Dow Chemical	Fresh Del Monte Produce Inc	Monsanto Co	Cuisine Solutions Inc	Penn Traffic Co*	Rite Aid Corp	Bristol Myers Squibb
6	Rayovac Corp	Du Pont De Nemours	Spigadoro Inc*	Potash Corp Sask Inc	Dean Foods Co	Publix Super Markets Inc	Walgreen Co	Cortex Pharmaceuticals Inc
7	U S Home & Garden Co*	Eastman Chemical Co		Scott Co	Del Monte Foods Co	Safeway Inc		Generex Biotechnology Corp
8	WD-40 Co	Engelhard Corp		United Industries Corp	Eagle Family Foods Hldgs Inc	Smart & Final Inc		IGI Inc
9		Fmc Corp			Farmer Bros Co	Supervalu Inc		Inline Pharmaceutical Co Inc
10		Frisby Technologies Inc*			Farmland Industries Inc*	Uni-Marts Inc*		Ivax Corp
11		Hercules Inc			Flowers Foods Inc	Whole Foods Market Inc		Johnson & Johnson
12		Olin Corp			Gardenburger Inc	Wild Oats Markets Inc		Leiner Health Products Inc*
13		Penford Corp			General Mills Inc	Winn-Dixie Stores Inc		Lilly & Co
14		Ppg Industries Inc			Heinz Co			Merck & Co

	Household Products (1)	Diversified Chemicals (2)	Agricultural Products (3)	Fertilizer & Agricultural Chemicals (4)	Packaged Food (5)	Food Retail (6)	Drug Retail (7)	Pharmaceuticals (8)
15		Solutia Inc			Hershey Foods Corp			Noven Pharmaceuticals Inc
16					Horizon Organic Holding*			Pacifichealth Laboratories
17					Hormel Foods Corp			Perrigo Co
18					Imperial Sugar Co			Pfizer Inc
19					Kellogg Co			Polydex Pharmaceuticals Ltd
20					Kraft Foods Inc			Salix Pharceuticals Ltd
21					Lance Inc			Schering-Plough
22					Land O Lakes Inc			Watson Pharmaceuticals Inc
23					McCormick & Co			Wyeth
24					New World Pasta Co*			
25					Peets Coffee & Tea Inc			
26					Pilgrims Pride Corp			
27					Sara Lee Corp			
28					Smithfield Foods Inc			
29					Smucker Co			
30					Tasty Baking Co			
31					Wrigley Jr Co			
32					Yocream Internaltional Inc			

*Those firms are bankrupted or merged with other firms and thus removed from analysis

Table A7.3: CRM Sample Firms by SIC Code

	Household Products (1)	Diversified Chemicals (2)	Agricultural Products (3)	Fertilizer & Agricultural Chemicals (4)	Packaged Food (5)	Food Retail (6)	Drug Retail (7)	Pharmaceuticals (8)
1	Colgate-Palmolive Co	BASF AG	Fresh Del Monte Produce Inc	Scotts Co	Campbell Soup Co	Kroger Co	CVS Corp	Abbott Laboratories
2	Dial Corporation*	BAYER AG	Spigadoro Inc*	U S Home & Garden Inc*	Dean Foods Co	Pathmark Stores Inc	Phar-Mor Inc*	Allegan Inc
3	Kimberly-Clark Corp	Cabot Corp		United Industries	Del Monte Foods Co		Rite Aid Corp	Bristol Myers Squibb
4	Proctor & Gamble Co	Dow Chemical			General Mills Inc		Walgreen Co	Cortex Pharmaceuticals Inc
5		Eastman Chemical Co			Hershey Foods Corp			Johnson & Johnson
6		Hercules Inc			Kellogg Co			Lannett Co Inc
7					Kraft Foods Inc			Merck & Co
8					McCormic & Co			MGI Pharma Inc
9					Peets Coffee & Tea Inc			Noven Pharmaceuticals Inc
10					Wrigley Jr Co			Pfizer Inc
11								Schering-Plough
12								Wyeth

*Those firms are bankrupted or merged with other firms and thus removed from analysis

Table A7.4: Relationship between Firm Size and Industry Effects

Parameter	B	Std. Error	T	Sig.
Household Products	.856	.451	1.897	.061
Diversified Chemicals	.782	.343	2.281	.025
Agricultural Products	1.167	.603	1.934	.056
Fertil. & Agri. Chemicals	.292	.451	.646	.520
Packaged Food	.526	.279	1.883	.063
Food Retail	1.515	.374	4.052	.000
Drug Retail	1.629	.533	3.058	.003
Pharmaceuticals (controlled)	0(a)	.	.	.

Table A7.5: GLM Analysis With and Without Size
using EBITDA as a Dependent Variable

	Without Size		With Size	
	t-value	Sig.	t-value	Sig.
Intercept	4.527	.000	5.001	.000
Size			8.126	.000
Household Products	-.021	.983	-1.675	.098
Diversified Chemicals	-1.147	.255	-3.446	.001
Agricultural Products	-1.096	.276	-3.107	.003
Fertil. & Agri. Chemicals	-1.799	.076	-2.962	.004
Packaged Food	-2.371	.020	-4.729	.000
Food Retail	-1.442	.153	-5.043	.000
Drug Retail	-1.019	.311	-3.860	.000
Pharmaceuticals (controlled)	.	.		

Table A7.6: ANOVA Analysis between Firm Size and Industry Effects

Industry category	Industry category	Sig.	Industry category	Industry category	Sig.
Household Products	Diversified Chemicals	1.000	Packaged Food	Household Products	1.000
	Agricultural Products	1.000		Diversified Chemicals	1.000
	Fertil. & Agri. Chem.	.974		Agricultural Products	.024
	Packaged Food	1.000		Fertil. & Agri. Chem.	1.000
	Food Retail	.933		Food Retail	.020
	Drug Retail	.823		Drug Retail	.026
	Pharmaceuticals	.872		Pharmaceuticals	.969
Diversified Chemicals	Diversified Chemicals	1.000	Food Retail	Household Products	.933
	Agricultural Products	.664		Diversified Chemicals	.242
	Fertil. & Agri. Chem.	.752		Agricultural Products	.809
	Packaged Food	1.000		Fertil. & Agri. Chem.	.009
	Food Retail	.242		Packaged Food	.020
	Drug Retail	.146		Drug Retail	1.000
	Pharmaceuticals	.579		Pharmaceuticals	.006
Agricultural Products	Household Products	1.000	Drug Retail	Household Products	.823
	Diversified Chemicals	.664		Diversified Chemicals	.146
	Fertil. & Agri. Chem.	.050		Agricultural Products	.502
	Packaged Food	.024		Fertil. & Agri. Chem.	.016
	Food Retail	.809		Packaged Food	.026
	Drug Retail	.502		Food Retail	1.000
	Pharmaceuticals	.027		Pharmaceuticals	.004
Fertilizer & Agricultural Chemicals	Household Products	.974	Pharmaceuticals	Household Products	.872
	Diversified Chemicals	.752		Diversified Chemicals	.579
	Agricultural Products	.050		Agricultural Products	.027
	Packaged Food	1.000		Fertil. & Agri. Chem.	1.000
	Food Retail	.009		Packaged Food	.969
	Drug Retail	.016		Food Retail	.006
	Pharmaceuticals	1.000		Drug Retail	.004

Tables A7.7 SCM Descriptive Analysis

Category	Items	Fre.	Mean	Std. Dev.	Skew	Min	Max
Structural capital	Cross-functional training	20	3.3	.31	11.88	0	4
	Decentralized decision-making	26	3.5	.38	10.31	0	4
Social capital	Vendor managed inventory	20	3.4	.32	12.00	0	5
	Supplier vendor relationships	132	2.72	.66	4.81	0	5
Community capital	Data standardization	96	2.76	.57	5.49	0	4
	Support for information sharing	24	3.17	.34	12.04	0	7
	Conference attendance	81	2.69	.50	5.58	0	3
Human capital	General training	185	3.2	.88	3.69	0	8
	SCM-specific training	38	3.00	.39	8.69	0	4
Foundational	Manufacturing	514	2.66	1.17	1.9	0	6
Synergistic	CRM strengths	38	81.37	13.71	14.23	0	287.9
	NPD	9	2.67	.17	18.13	0	4
Management	SCM Award	14	.93	.07	13.62	0	1
	Technology-Award	33	.97	48.86	8.59	0	1

Tables A7.8 CRM Descriptive Analysis

Category	Items	Fre.	Mean	Std. Dev.	Skew	Min	Max
Structural capital	Cross-functional training	7	2.86	.22	16.83	0	4
	Decentralized decision-making	5	3.2	.21	18.92	0	4
Social capital	Customization	27	3.33	.47	7.68	0	4
	Market collaboration	19	1.95	.23	9.31	0	3
Community capital	Data standardization	60	2.77	.59	5.3	0	4
	Support for information sharing	15	2.93	.32	10.92	0	4
	Employee empowerment	10	3.2	.29	13.10	0	4
Human capital	Conference attendance	38	2.71	.28	10.50	0	3
	General IT training	15	3.27	.35	10.43	0	14
Foundational	Integrated data repository	13	2.62	.28	12.66	0	4
	Data warehousing	.12	3.42	.33	11.91	0	5
	ERP	44	3.16	.57	5.93	0	4
Synergistic	SCM	38	55.92	11.46	10.86	0	199
	NPD	33	2.76	.44	7.21	0	5
	R&D	389	3.13	1.48	1.34	0	5
	Data mining	10	2.7	.25	14.21	0	4
Management	CRM-related award	3	.67	.037	26.81	0	1
	Technology-related award	18	.94	.11	90.05	0	1

Table A7.9: CRM Hierarchical Regression Model – Sales per Employee

	Model 1	**Model 2**	**Model 3**	**Model 4**
	t-value	t-value	t-value	t-value
Intercept	15.740****	13.671****	12.458****	14.575****
Structural	.998	.751	1.700*	1.463
Social	.028	.978	.378	1.083
Community	.930	.434	-1.122	.270
Human	-.823	.432	-.299	1.247
ST * FD		.171		
SO * FD		-.940		
CO * FD		-.169		
HU * FD		-.458		
ST * SY			-1.486	
SO * SY			-.468	
CO * SY			1.370	
HU * SY			.074	
ST * MC				-.655
SO * MC				-1.790*
CO * MC				.049
HU * MC				-1.290
df	4, 32	8, 28	8, 28	8, 28
Adjusted R^2	-.029	-.084	-.047	.048
R^2	.085	.157	.185	.259
(F, p)	(.745, .568)	(.650, .729)	(.797, .610)	(1.225, .321)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Table A7.10: CRM Hierarchical Regression Model – Gross Profit

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	t-value	t-value	t-value	t-value	t-value
Intercept	-3.148***	-2.088**	-1.928*	-2.548**	-1.826*
Size	4.880****	3.540***	3.415***	3.811****	3.421***
Structural		2.478**	2.561**	-1.068	.126
Social		.729	-.666	-.695	-.072
Community		-.017	.531	-.415	1.552
Human		-.509	1.099	-.438	.054
ST * FD			-.446		
SO * FD			1.757*		
CO * FD			-.254		
HU * FD			-1.644*		
ST * SY				1.761*	
SO * SY				1.072	
CO * SY				.452	
HU * SY				.046	
ST * MC					1.300
SO * MC					2.481**
CO * MC					-2.038**
HU * MC					-1.524
df	1, 36	5, 32	9, 28	9, 28	9, 28
Adjusted R^2	.381	.433	.450	.508	.538
R^2 (F, p)	.398 (23.82, .000)	.509 (6.65, .000)	.584 (4.37, .001)	.628 (5.25, .000)	.651 (5.80, .000)
ΔR^2 (F, p)		.111 (.999, .423)	.186 (1.83, .148)	.23 (2.39, .072)	.253 (2.71, .048)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Table A7.11: CRM Hierarchical Regression Model – Net Cash Flow

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	t-value	t-value	t-value	t-value	t-value
Intercept	-2.379**	-1.603	-1.452	-2.118**	-1.078
Size	3.727****	2.692***	2.528**	2.989***	2.170**
Structural		2.324**	2.334**	-.690	.437
Social		.342	-.528	-.304	-.025
Community		.032	.496	-.962	1.642*
Human		.092	1.214	-.244	.451
ST * FD			-.477		
SO * FD			1.212		
CO * FD			-.298		
HU * FD			-1.386		
ST * SY				1.329	
SO * SY				.481	
CO * SY				1.018	
HU * SY				.032	
ST * MC					1.114
SO * MC					1.224
CO * MC					-2.215**
HU * MC					-1.331
df	1, 33	5, 29	9, 25	9, 25	9, 25
Adjusted R^2	.275	.313	.297	.376	.380
R^2 (F, p)	.296 (13.894, .001)	.414 (4.103, .006)	.483 (2.594, .029)	.541 (3.28, .009)	.544 (3.318, .008)
ΔR^2 (F, p)		.118 (.97, .439)	.187 (1.67, .184)	.245 (2.35, .078)	.248 (2.39, .074)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Table A7.12: CRM Hierarchical Regression Model – EBITDA

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	t-value	t-value	t-value	t-value	t-value
Intercept	-2.848***	-1.758*	-1.560	-2.169**	-1.270
Size	4.422****	3.069***	2.853***	3.248***	2.670***
Structural		2.450**	2.403**	-.525	.688
Social		.746	-.310	-.221	.029
Community		.198	.631	-.790	1.821*
Human		-.432	.990	-.392	.184
ST * FD			-.406		
SO * FD			1.262		
CO * FD			-.352		
HU * FD			-1.387		
ST * SY				1.175	
SO * SY				.544	
CO * SY				.892	
HU * SY				.062	
ST * MC					.794
SO * MC					1.986**
CO * MC					-2.250**
HU * MC					-1.516
df	1, 36	5, 32	9, 28	9, 28	9, 28
Adjusted R^2	.334	.388	.374	.425	.471
R^2 (F, p)	.352 (19.552, .000)	.471 (5.699, .001)	.526 (3.453, .006)	.565 (4.038, .002)	.600 (4.658, .001)
ΔR^2 (F, p)		.119 (1.08, .383)	.174 (1.69, .178)	.213 (2.165, .096)	.248 (2.64, .052)

*p<.1, ** p<.05, *** p<.01, **** p<.001

Legend: FD: Foundational Capability, SY: Synergistic Capability, MC: Management Capability, ST; Structural, SO: Social, CO: Community; HU; Human

Table A7.13: The Purposes of Training among the Sample Firms**

Purposes
Salespeople training (technical functionality training, communication skills, decision making skills, cross-selling and up-selling)
New technical training when it is upgraded.
Training for new products and the products of competitors to, especially the new employees
New employee training
Regular training
Sales representative training based on customers' feedbacks.
Customer order entry skill, and computer training
Retrieving pricing and product information
Retrieving the history of customer information from the database
Training to assist decision-makers in areas such as industry knowledge, pricing strategy, forecasting, merger analysis,
Firm' sales strategy training (e.g., Hershey's Blue Chip strategy to their salespeople, or Wild Oats' firm's strategy on customer)

** This table is based on those firms that provide their investment purposes

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