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Digitally Enhancing Customer Agility and Competitive Activity: How Firms Use Information Technology to Sense and Respond to Market Opportunities in Hypercompetitive Environments

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DIGITALLY ENHANCING CUSTOMER AGILITY AND COMPETITIVE ACTIVITY: HOW FIRMS USE INFORMATION TECHNOLOGY TO SENSE AND RESPOND TO MARKET OPPORTUNITIES IN HYPERCOMPETITIVE ENVIRONMENTS

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ABSTRACT

This dissertation studies how information technology (IT) facilitates customer agility and, in turn, competitive activity. Customer agility refers to the extent to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. As such, customer agility consists of two key dimensions: sensing and responding. We propose that IT plays a critical role in facilitating a firm's customer agility – in particular, its sensing and responding components.

The Internet has spawned a rich set of tools that allow firms to engage in rich, interactive dialogues with a broad and diverse customer base, thereby enhancing firms' ability to sense and respond to shifting customer needs and preferences. Although academics and practitioners suggest that IT is a key enabler of customer agility, we know little concerning how and why IT facilitates customer agility. Building on the dynamic capability literature, we propose that the "knowledge creating" synergy derived from the interaction between a firm's web-based infrastructure and its analytical ability will enhance the firm's ability to sense customer-based opportunities, and the "process enhancing" synergy obtained from the interaction between a firm's coordination efforts and its level of IT integration will facilitate the firm's ability to respond to those opportunities. Finally, we propose that the alignment between customer sensing capability and customer responding capability will impact the firm's competitive activity.

We test our model with a two-stage longitudinal research design in which we survey marketing executives of high-tech firms. Our results find that web-based (resource and user) infrastructure has a significant effect on customer sensing capability. Moreover, analytical ability

positively moderates these relationships. We also find that interfunctional coordination and channel coordination both have a significant impact on customer responding capability. Furthermore, internal information systems (IS) integration positively moderates the interfunctional-response relationship, yet external IS integration does not moderate the channel-response relationship.

Our results also show that varying types of alignment between customer sensing capability and customer responding capability are related to different types of competitive activity. Specifically, a higher "match" between sensing and responding results in actions which effectively meet or address customer needs. Furthermore, customer responding quality mediates the relationship between customer sensing capability and 1) number of actions executed and 2) the speed at which firms respond to changing customer needs. We also find that agility alignment is not related to action repertoire complexity.

Our results have implications for both research and practice. To our knowledge, it is the first study to conceptualize and test a comprehensive yet parsimonious research model which includes the role of IT, customer agility and competitive activity. In doing so, we contribute to the IT business value literature, dynamic capabilities research, competitive dynamics literature, and organizational innovation research. We also give managers greater insight into how they can effectively leverage IT resources when sensing and responding to their customers in turbulent environments.

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CHAPTER ONE: INTRODUCTION

1.0 Introduction

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change." – Charles Darwin

Agility is emerging as the ultimate competitive weapon in contemporary business environments. Industries once considered to be relatively stable, such as the food retailing industry (Meloche and Plank 2006) and the Japanese beer industry (Craig 1996), have evolved into fiercely competitive environments in which long-established industry giants are being threatened by nimble start-up firms scattered across the globe (Engardio 2006). The increasing pace of globalization, competitive rivalry, shifting customer demands, and rapid technological advancements creates an environment in which sustained competitive advantage is difficult – if not impossible – to achieve (D'Aveni 1994).

Agile firms are able to adapt to and perform well in rapidly changing environments (Sambamurthy et al. 2003; Sull 2009). Agility underlies firms' success in continually enhancing and redefining their value creation and competitive performance by capitalizing on opportunities for innovation and competitive action (Brown and Eisenhardt 1997; Christensen 1997; D'Aveni 1994). Specifically, agility consists of two components – sensing and responding – both of which are key organizational capabilities that contribute to success in hypercompetitive environments (Zaheer and Zaheer 1997). A firm may be agile in various areas, such as its customer-based processes, interactions with supply chain partners, and day-to-day operations (Sambamurthy et al. 2003). This study focuses on customer agility, which is defined as the

degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. By customer we refer to the traditional consumer, e.g., an individual who purchases a cup of coffee at Starbucks. We do not include firm-level customers or suppliers, e.g., Enterprise Rent-a-Car purchases mass quantities of automobiles from Toyota.

The advent of new information and communication technologies presents fascinating and powerful opportunities for firms to enhance their customer agility. In particular, an explosive emergence of web-based technologies has initiated a sweeping transformation of customer-producer relationships in many industries (Prandelli et al. 2006). New technologies have greatly enhanced the level of connectivity between customers and producers in a cost-effective manner, thereby allowing firms to better sense and respond to shifts in customer preferences and opportunities for innovation. For instance, the rapid evolution and maturation of social computing technologies, such as blogs, peer-to-peer networks, wikis, and photo and video sharing communities enable "a shift from a perspective of exploiting customer knowledge by the firm to a perspective of knowledge co-creation with customers" (Sawhney and Prandelli 2000, p. 31). Contemporary firms are leveraging these technologies to embrace open models of innovation in which the customer is a vital partner (Nambisan and Sawhney 2008). For example, Volvo has created an ad-hoc site – conceptlabvolvo.com – where customers choose the new automobile concepts they like best, and Proctor & Gamble has deployed technologies such as data mining, simulation, prototyping, and visual representation to involve customers in its innovation processes (Dodgson et al. 2006). Firms competing in the electronics and automobile industries employ a diverse range of web-based tools to sense and respond to customer input in the new product development process (Prandelli et al. 2006). For instance, BMW provides a web

site (www.bmw.com) that allows customers to “build” their own automobiles by customizing features and accessories.

Internet-based technologies allow broad communities of interest to coalesce around specific products and services (Williams and Cothrel 2000). These online communities facilitate distributed innovation models that involve varied customer roles in new product development (Nambisan 2002; Sawhney and Prandelli 2000). For example, organizations are using web-based collaboration technologies such as wikis to sense and respond to customers engaged in the creation of new products and services (Wagner and Majchrzak 2007). Not only can customers generate ideas for new products and services, they can also test products and provide end user product support in online environments (Prandelli et al. 2006). Customers are using technological toolkits for user innovation to take on problem-solving tasks and design computer games – such as *The Sims* – to fit their individual needs (Prugl and Schreier 2006). As a result, firms are responding to individuals on a scale of “mass customization” (Pine 1993). More importantly, the social relationships that take hold between the various entities in online communities generate a continuous flux of valuable knowledge (Brown and Duguid 1991; Nahapiet and Ghoshal 1998; Nonaka and Konno 1998). These studies show that firms are increasingly recognizing the power of the Internet as a platform for sensing and responding to customer-based opportunities for innovation and competitive action (Bernoff and Li 2008; Sawhney et al. 2005).

Practitioners argue that IT could become the driving force behind strategic competitive advantage in dynamic, turbulent environments (D'Aveni 1994; Haeckel 1999). Theory also suggests that IT provides the foundation for digital options which greatly enhance customer

agility (Sambamurthy et al. 2003). Yet despite the importance of IT and customer agility in hypercompetitive environments, we know little concerning how and why IT supports customer agility and, in turn, competitive activity. Hence, this study's broad research objective is *to understand how IT facilitates customer agility*. In addition, this study will investigate the nature of customer agility and its impact on competitive activity. In this chapter we briefly describe a number of contributing theoretical perspectives, propose a high-level research model, state our study's objectives, describe the research context, and detail our contributions to research and practice.

1.1 Theoretical Perspectives

We draw from a variety of rich theoretical perspectives from multiple disciplines to inform our understanding of the nomological net surrounding IT, customer agility and competitive activity. First, the dynamic capabilities literature increases our appreciation of the distinct nature of customer agility. Dynamic capabilities refer to the processes by which firms reconfigure their operating routines and resource base in pursuit of improved organizational effectiveness (Zollo and Winter 2002). Developing and maintaining a repertoire of dynamic capabilities is imperative in fast-paced, turbulent environments (Eisenhardt and Martin 2000; Teece et al. 1997). We conceptualize customer agility as a dynamic capability; specifically, customer agility refers to the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. We also recognize that sensing and responding are distinct components of customer agility (Haeckel 1999; Overby et al. 2006). As such, our review of the literature finds that organizational "knowledge-based" resources and capabilities facilitate customer sensing capability, and organizational "process-

based" resources and capabilities enhance customer responding capability (Dove 2001; Sambamurthy et al. 2003; Teece 2007).

Secondly, we review the capability alignment literature to examine the relationship between customer sensing capability and customer responding capability. Researchers note that alignment of a firm's capabilities is critical to firm success in dynamic environments (Helfat et al. 2007). With respect to customer agility, a firm's sensing and responding capabilities need to be simultaneously developed and applied in order for the firm to reap the maximum benefits of customer agility (Haeckel 1999; Overby et al. 2006). Hence, we draw upon prior research on strategic "fit" (Venkatraman 1989b) to conceptualize three perspectives of agility alignment: moderation, matching and mediation. We compare and contrast each perspective in order to gain a deeper understanding of the various ways in which firms can align their customer sensing and customer responding capabilities.

Our third major theoretical perspective is competitive dynamics. Based on Schumpeter's (1939) theory of competitive behavior, research in competitive dynamics attempts to understand how and why firms undertake actions to (1) create competitive advantage and (2) disrupt existing conceptualizations about the industry (Chen 1996; Young et al. 1996). The Austrian school of economics posits that all action is undertaken in the pursuit of profit-building opportunities (Kirzner 1997). Thus, competitive actions mediate the relationship between firms' capabilities and financial performance (D'Aveni 1994; Ferrier 2001). Moreover, competitive activity measures how well a firm senses and responds to customer-based opportunities for innovation and competitive action. Thus, we adopt a competitive dynamics perspective in our study.

Finally, we examine the IT business value research to gain an appreciation of how IT can contribute to a firm's customer agility. We find that IT capabilities create firm value through intermediate or interactive effects. Specifically, the synergistic effect of IT capabilities and complimentary organizational factors often contributes to enhanced firm performance, competitive advantage and other salient value-based outcomes. Building on this research, we examine how IT capabilities create digital options that, in turn, enhance customer agility. In particular, digital knowledge capabilities facilitate customer sensing capability, and digital process capabilities facilitate customer responding capability. The next section synthesizes these views to build a nomological net linking IT, customer agility and competitive activity.

1.2 Study Objectives

Our broad research objective is to understand how IT facilitates customer agility. Specifically, we address the following research questions:

- *What is customer agility?* Although agility has been mentioned as a key organizational capability, and different types of agility (e.g., customer, partner, strategic) have been noted (Sull 2009), scholars have not fully conceptualized and measured customer agility. We aim to gain a fuller understanding of customer agility by distinguishing it from related concepts, measuring it, and examining its antecedents and consequences.

- *How does information technology facilitate the sensing and responding components of customer agility?* While scholars have theorized how IT facilitates agility (Sambamurthy et al. 2003), little empirical work has been conducted regarding the nomological network surrounding IT and agility. In particular, researchers have not conceptualized

and empirically tested the extent to which IT enhances the sensing and responding dimensions of customer agility. We intend to undertake that endeavor in this study.

- *What is the effect of customer agility on competitive activity?* The competitive dynamics literature describes the conditions under which firms initiate and react to competitive actions (Smith et al. 2001). However, to the best of our knowledge, no one has examined the relationship between agility – in particular customer agility – and competitive activity. If customer agility is a key organizational capability in turbulent environments (D'Aveni 1994; Sull 2009), it is important that we understand how customer agility manifests itself in competitive outcomes and long-term firm performance.

1.3 Research Framework

Figure 1.1 depicts a high-level research framework for our study. We propose that IT-enabled micro-foundations (resources and capabilities) moderate the relationship between organizational knowledge-based micro-foundations and customer sensing capability. Further, IT-enabled micro-foundations moderate the relationship between organizational process-based micro-foundations and customer responding capability. On the right-hand side, customer agility will have a positive effect on the firm's competitive activity.

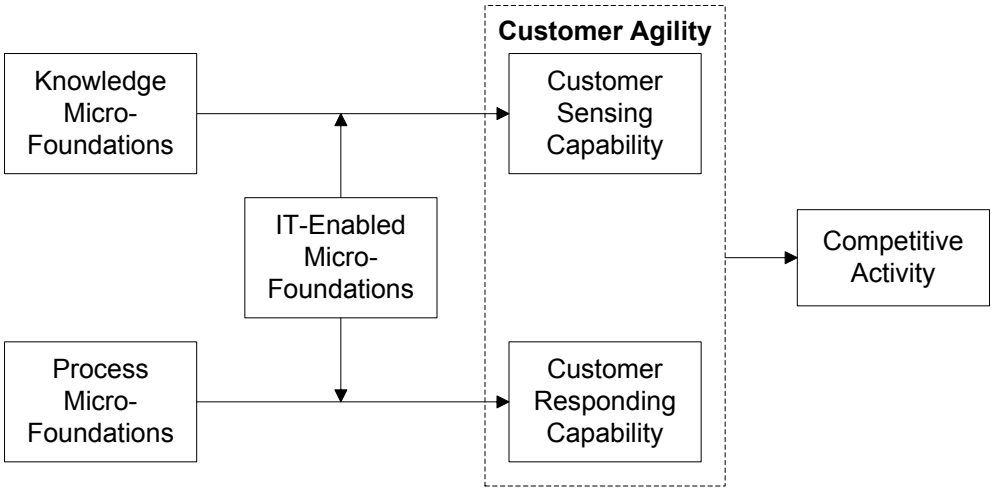


Figure 1.1. Basic Research Framework

In particular, knowledge-based micro-foundations refer to the firm's web-based infrastructure – the set of web-based tools which facilitate the customer's role in new product development processes – and process-based micro-foundations consist of interfunctional coordination and channel coordination. Key IT-enabled moderators are analytical ability, internal IS integration and external IS integration. Specifically, we propose that analytical ability will moderate the relationship between web-based infrastructure and customer sensing capability. Also, internal IS integration will moderate the relationship between interfunctional coordination and customer responding capability. Finally, external IS integration will moderate the relationship between channel coordination and customer responding capability. We also investigate multiple ways in which customer sensing capability and customer responding capability might be aligned. This degree of agility alignment will impact the firm's competitive activity. Finally, we conceptualize and measure competitive activity in four ways: action volume, action repertoire complexity, customer response quality, and customer response speed.

1.4 Empirical Setting

We undertake our study in the context of new product development (NPD). Firms are moving from closed to open models of innovation in which they contribute to and draw from multiple partners (Chesbrough 2003; Pisano and Verganti 2008). One key product innovation partner is the customer (Sawhney et al. 2005). By integrating their customers in NPD processes, firms are better able to sense and respond to customer-based opportunities for innovation and competitive action. For example, Ducati motorcycle company hosts a web site in which customers participate in forums that address a wide variety of motorcycle-related issues (Sawhney et al. 2005). In this virtual environment, customers can share their projects for customizing motorcycles, provide suggestions to improve Ducati's next generation products, and even post their own mechanical and technical designs, with suggestions for innovations in aesthetic attributes as well as mechanical functions. By developing, maintaining and participating in these IT-enabled communities, Ducati can easily sense customer-based opportunities and respond appropriately.

We empirically test our research model in a dynamic, high-tech environment. Specifically, we collect data characterizing firms operating in the computer manufacturing and prepackaged software markets. These firms are more likely to require high levels of customer agility (Haeckel 1999). We survey marketing managers as our key informant regarding the firm's organizational characteristics. We also collect secondary data on the firm's web-based infrastructure. Finally, we administer a second follow-up survey of the initial respondents to strengthen our study's validity and rigor.

1.5 Contributions

Research investigating the role of IT and organizational agility, in particular customer agility, is in its infancy. This dissertation aims to make a number of contributions to research and practice.

1.5.1 Contributions to Research

This study makes several contributions to research, one of which is conceptualizing customer agility. While agility has been proposed as a critical success factor in hypercompetitive environments (Sull 2009), to the best of our knowledge no work has comprehensively examined the nature of customer agility. In addition to developing and testing a research model with antecedents and consequences of customer agility, we provide a framework in which future research can further investigate how firms can develop and leverage customer agility to improve their long-term performance. We also distinguish customer agility from a number of related concepts. For instance, customer agility is similar to absorptive capacity, exploration/exploitation and market orientation. However, we show that customer agility is a unique construct that overlaps yet discriminates from like constructs. In doing so we contribute to the emerging literature on organizational agility.

We also conceptualize customer agility as two fundamental components: customer sensing capability and customer responding capability. In doing so we are able to explore different ways in which firms can align their sensing and responding capabilities. Specifically, we investigate agility alignment as moderation, matching and mediation. Conceptualizing and testing these various types of alignment provides deeper insight into the nature of customer agility and its impact on competitive activity.

We also provide empirical support for the role of dynamic capabilities in facilitating firms' competitive activity in turbulent environments. Although the dynamic capabilities literature has been criticized for lack of empirical grounding (Williamson 1999), we find that customer agility is an identifiable and measurable dynamic capability that contributes to a firm's competitive activity. By conceptualizing and testing the relationship between customer agility and competitive activity, we identify a salient outcome of dynamic capabilities and avoid the dynamic capability-competitive advantage tautology. Finally, we link organizational micro-foundations to customer agility, thereby providing empirical support to nascent dynamic capability frameworks (Teece 2007). Specifically, sensing and responding are enhanced by distinct antecedents: knowledge-based micro-foundations and process-based micro-foundations, respectively. Our study contributes both theoretically and empirically to the rapidly growing dynamic capabilities research stream.

By conceptualizing and testing the facilitating role of IT in customer agility and competitive activity processes, we contribute to the IT business value literature. While the notion of IT capabilities has been discussed and researched for some time now (cf. Bharadwaj 2000; Wade and Hulland 2004), very few studies have attempted to open the black box of IT capabilities. One reason for this limitation is that prior research often used broad IT-related constructs that prevented consistent, unambiguous and readily comparable studies on the strategic role of the IT artifact (Piccoli and Ives 2005). We open this box by conceptualizing and measuring specific IT capabilities and resources that directly generate business value. Yet we also recognize that IT often does not create value in isolation; instead, value may arise from interactive synergies created by IT capabilities and complimentary organizational factors (Powell

and Dent-Micallef 1997). Thus, we conceptualize and measure the "knowledge creating" synergy and "process enhancing" synergy created by the intersection of particular IT capabilities and organizational factors.

Recent work accepts that there are a number of factors that mediate the relationship between IT and value creation (Devaraj and Kohli 2002; Kohli and Grover 2008). Extending the indirect view, we propose a research model that delineates the mechanisms by which digital knowledge-based capabilities facilitate customer sensing capability and digital process-based capabilities enhance customer responding capability. In doing so we show that IT contributes to firm value through intermediate processes (i.e., customer agility). Specifically, IT capabilities interact with complementary organizational resources to facilitate customer agility, and customer agility mediates the effect of these interactive factors on competitive activity.

We also contribute to the competitive dynamics literature. Despite a long stream of conceptual and empirical work (Ketchen et al. 2004), competitive dynamics researchers have not examined the relationship between customer agility and competitive activity. Furthermore, much of the prior empirical work on competitive dynamics investigates the relationship between descriptive organizational characteristics (e.g., top management team heterogeneity) and competitive activity (Smith et al. 2001). Our study is one of the first that moves beyond a static, "organizational characteristics-activity" link to more of a dynamic, "capability-activity" relationship.

Competitive dynamics researchers tend to focus on the quantity or repertoire of actions a firm undertakes (Ketchen et al. 2004), as opposed to the quality or efficacy of actions. We conceptualize and validate two new measures of competitive activity: customer response

quality and customer response speed. In doing so we gain a better understanding of how a firm's customer agility can impact the extent to which its competitive actions meet or address customer needs, as well as how quickly firms can execute such actions. We believe that investigating how a firm executes effective actions in the marketplace will provide deeper understanding into research on competitive dynamics.

Finally, this study contributes to the emerging "open innovation" literature. Firms are increasingly moving toward open models of innovation in which they combine external ideas with internal ideas to create innovative products and services (Chesbrough 2003). One external source of ideas is a firm's customers. However, high connectivity barriers between customers and firms have prohibited customers from playing integrative roles in innovation processes. Recent advances in IT have reduced these barriers, thereby allowing customers to contribute to open innovation practices. In particular, our results show that firm-hosted online communities help firms sense customer-based opportunities for innovation. Thus, our study contributes to the innovation literature.

1.5.2 Contributions to Practice

From a managerial perspective, we describe specific and identifiable factors that affect customer-based agile practices in turbulent environments. Managers realize that sensing and responding to customer-based opportunities for innovation is an important capability (Mollick 2005; Prahalad and Ramaswamy 2004), yet they may not know the best way to leverage customer knowledge and information (Berthon et al. 2007). This study shows that key organizational factors combined with IT capabilities impact the firm's customer agility. Thus, managers can manipulate certain organizational factors to place their firm in a better position to

sense and respond to customer-based opportunities for innovation and competitive action. By demarcating customer sensing capability and customer responding capability, we also contribute to managers' understanding of which levers to pull for each one.

Our results suggest that managers should develop and maintain a repertoire of web-based tools that allow customers to perform a variety of NPD-related roles. In doing so, customers are more likely to offer recommendations on how the firm can improve existing products and services, assist peers in troubleshooting problems, and suggest ideas for new products and services. The extended reach, enhanced interactivity, and greater flexibility provided by web-based tools generate a wealth of information that managers can then leverage to determine customers' expressed and latent needs. As a result, firms are more likely to sense a range of potential market opportunities.

Our results also contribute to managers' understanding of how to leverage analytical tools. We find that firms must have a sufficient level of data before they can effectively use analytical tools. Yet managers who take advantage of the synergies arising from voluminous amounts of web-based data from customers and data mining analytical capabilities will improve their ability to sense customer-based market opportunities in a relevant and timely manner.

Our findings suggest that managers should cultivate both interfunctional coordination mechanisms and channel coordination processes. By doing so their firm will be better positioned to respond quickly when opportunity presents itself. Furthermore, integration of a firm's internal information systems speeds the flow of information, thereby magnifying the effect of interfunctional coordination on response ability.

Finally, our results suggest that managers would do well to align their sensing and responding capabilities. Specifically, while it is important that sensing and responding should be balanced, managers should focus on sensing processes when they desire to create products and services which meet customers' needs and preferences. Without a strong customer sensing capability in place, firms cannot execute effective actions in the marketplace. On the other hand, strong customer response processes are required in order to quickly execute customer-based opportunities for innovation and competitive action.

1.6 Structure of the Dissertation

This dissertation unfolds as follows. In the second chapter we review literature pertinent to the formulation of our research model. We first examine definitions of agility proposed in the extant literature to arrive at an initial working definition of customer agility. We then review concepts related to customer agility – in particular, absorptive capacity, exploration/exploitation and market orientation – to achieve a better understanding of the distinct nature of customer agility. Following this, we position customer agility within three key organizational perspectives: dynamic capabilities, capability alignment and competitive dynamics. In doing so we construct a nomological net surrounding customer agility, a net in which we conceptualize the powerful facilitating role of IT. Finally, Chapter 2 also includes a review of the organizational product innovation literature to build a context in which we can investigate how firms can leverage IT to sense and respond to customer-based opportunities for innovation and competitive action in hypercompetitive environments.

In Chapter 3 we build on our review of the literature to present our research model, define our constructs, and propose research hypotheses. We conceptualize customer agility as a

dynamic capability with two distinct components: customer sensing capability and customer responding capability. Knowledge-based micro-foundations enhance customer sensing capability, and process-based micro-foundations facilitate customer responding capability. Furthermore, IT resources and capabilities exhibit direct and moderating effects on customer agility. In the second part of the model, we propose that customer agility alignment will be positively related to competitive activity.

In Chapter 4 we describe procedures and methods used to test the research model. We discuss the research design, including unit of analysis, key informant, target sample frame, desired sample size, and survey administration. We then describe measures for the constructs in our research model, including their underlying structure. Finally, we explain our plan for data analysis, including the preparation phase, measurement validation and structural validation.

In Chapter 5 we describe the results of our data analyses. We discuss the development of survey one and survey two, followed by a description of our sample. We then assess our constructs' measurement properties (e.g., construct validity, reliability, descriptive statistics) and potential problems due to non-response bias and common method bias. In the next section we assess the structural model and test our research hypotheses. We then present the results of our qualitative analyses.

Finally, in Chapter 6 we discuss key findings from our data analyses, implications for research, and implications for managers. We also note this study's limitations and directions for future research, followed by concluding thoughts.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

In this chapter we discuss the relevant theories and research streams that contribute toward the theoretical development of the research model. Our primary objective is to identify and synthesize extant research germane to this study, discover critical research gaps, and understand how this study will contribute toward filling these gaps in existing literature. We draw from multiple disciplines, including information systems, marketing, organizational science, and strategy.

Specifically, we review prior definitions of agility to arrive at a working definition of customer agility. We then build upon concepts related to customer agility, such as absorptive capacity, exploration/exploitation and market orientation, to gain a better understanding of the distinctive nature of customer agility. Following this, we situate customer agility within three research streams: dynamic capabilities, capability alignment and competitive dynamics. In doing so we uncover a nomological net surrounding customer agility. We also conceptualize the role of IT as a facilitator of customer agility. Finally, we draw upon the organizational product innovation literature to create a context in which firms can leverage IT and customer agility to sense and respond to opportunities for innovation and competitive action.

2.1 Defining and Distinguishing Customer Agility

The notion of customer agility builds upon several concepts in various disciplines that pertain to firm success and organizational survival in turbulent environments. In the following sections we review definitions of organizational agility to arrive at a working definition of

customer agility. We then examine how customer agility can be distinguished from related concepts; specifically, absorptive capacity, exploration/exploitation and market orientation.

2.1.1 What is Customer Agility?

The problem of how organizations can successfully deal with unpredictable, dynamic and constantly changing environments has been a topic of great interest both in industry and academe for several decades. Among the solutions proposed, adaptation, agility and flexibility have emerged as the most popular. Research on organizational adaptation investigates how the organization's form, structure and degree of formalization influenced the ability to adapt (Burns and Stalker 1961; Hage and Aiken 1969; Hage and Dewar 1973). Studies of organizational flexibility build on adaptation research and examine the organization's ability to adapt and respond to change (Toni and Tonchia 1998; Volberda 1996). As the latest concept to emerge, organizational agility builds on the adaptation/flexibility literature, as well as research on agile manufacturing. Table 2.1 provides numerous definitions of agility harvested from the literature. In the following section we note the major definitions and find emerging themes shared among them.

Table 2.1. Definitions of Agility in the Extant Literature

Source	Definition
Goldman et al. (1995)	Comprehensive response to the business challenges of profiting from rapidly changing, continually fragmenting, global markets for high-quality, customer-configured goods and services
Cho et al. (1996)	The capability of surviving and prospering in a competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets driven by customer designed products and services
Gould (1997)	Constantly reconfigure strategies and processes and examination of their marketing positioning

Source	Definition
Bal et al. (1999)	The response to coping with uncertainty and the basis for achieving competitive advantage in changing market conditions
Bititci et al. (1999)	The business' ability to quickly adapt and change in response to rapidly changing environmental conditions
McGaughey (1999)	The ability of an enterprise to respond quickly and successfully to change
Sharifi and Zhang (1999)	Ability to cope with unexpected changes, to survive unprecedented threats of business environment, and to take advantage of changes as opportunities
Vernadat (1999)	The ability to closely align enterprise systems to changing business needs in order to achieve competitive performance
Yusuf et al. (1999)	The successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment… the ability of a business to grow in a competitive market of continuous and unanticipated change, to respond quickly to rapidly changing markets driven by customer-based valuing of products and services
Day et al. (2000)	The ability of an organization to thrive in a constantly changing, unpredictable environment
Langer and Alting (2000)	Agility is a means of thriving in an environment of continuous change by managing complex inter and intra firm relationships through innovations in technology, information, communication, organization design, and new marketing strategies
Schonsleben (2000)	Agile firms are those who understand how to remain competitive by means of proactive amassing of knowledge and competencies
Bessant et al. (2001)	The ability of a firm to respond quickly and flexibly to its environment and to meet the emerging challenges with innovative responses
Dove (2001)	The ability to manage and apply knowledge effectively, so that an organization has the potential to thrive in a continuously changing and unpredictable business environment
Sambamurthy et al. (2003)	The ability to detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise
Sambamurthy et al. (2003)	Customer agility is the co-opting of customers in the exploration and exploitation of opportunities for innovation and competitive action moves
Sambamurthy et al. (2003)	Partnering agility is the ability to leverage the assets, knowledge, and competencies of suppliers, distributors, contract manufacturers, and logistics providers through alliances, partnerships, and joint ventures

Source	Definition
Sambamurthy et al. (2003)	Operational agility is the ability of firms' business processes to accomplish speed, accuracy, and cost economy in the exploitation of opportunities for innovation and competitive action
Arteta and Giachetti (2004)	The ability to respond to unanticipated change (response ability) but also to act proactively with regard to change (knowledge management)
Lin et al. (2006)	Supply chain agility is the integration of customer sensitivity, organization, processes, networks and information systems
Overby et al. (2006)	The ability of firms to sense environmental change and respond readily
Van Oosterhout et al. (2006)	Business agility is being able to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage unpredictable external and internal changes
Fink and Neumann (2007)	IT-dependent information agility is the ability to easily accommodate change in the way organizational users access and use information resources
Fink and Neumann (2007)	IT-dependent strategic agility is the ability to respond efficiently and effectively to emerging market opportunities by taking advantage of existing IT capabilities
Fink and Neumann (2007)	IT-dependent system agility is the ability to accommodate change in information systems without incurring significant penalty in time or cost
Gallagher and Worrell (2008)	The ability to sense and respond to changes in an organization's internal and external environment by quickly assembling resources, relationships and capabilities
Setia et al. (2008)	An organization's ability to: (1) Discover new opportunities for competitive advantage; (2) Harness the existing knowledge, assets, and relationships to seize these opportunities; and (3) Adapt to sudden changes in business conditions
Tallon (2008)	Business process agility is the extent to which a firm reacts to change by altering how it performs business activities
Braunscheidel and Suresh (2009)	Firm's supply chain agility is the capability of the firm, internally, and in conjunction with its key suppliers and customers, to adapt or respond in a speedy manner to a changing marketplace, contributing to agility of the extended supply chain

Goldman et al. (1995) proposed four strategic dimensions that form an agility capability: (1) enriching the customer, (2) cooperating to enhance competitiveness, (3) organizing to master changes, and (4) leveraging the impact of people and information. Customer enrichment refers to the effective delivery of value and solutions to customers, as opposed to simply

offering products and services. The firm must also cooperate internally (among sub-units) and externally (with suppliers and other business partners) in order to quickly seize opportunities in the marketplace. Effective mastering of change requires flexible organizational structures that enable rapid reconfiguration of organizational resources. Finally, an agile firm continuously invests in its human resources in order to maintain future success.

Yusuf et al. (1999) identified four dimensions of agile manufacturing: (1) core competence management, (2) virtual enterprise formation, (3) capability reconfiguration, and (4) knowledge-driven enterprise. The development of a strategic architecture presents an organizational-wide map of core skills that may allow the firm to make rapid changes when opportunities arise. Key enablers of agility include speed, flexibility, innovation, proactivity, quality, and profitability.

Dove (2001) attempts to move away from the manufacturing realm to a broader notion of enterprise agility. Specifically, Dove defines agility as the ability to manage and apply knowledge effectively. The organization's agility is dependent on its ability to adapt. Hence, Dove proposes four types of adaptable manufacturing enterprise environments: (1) product, (2) process, (3) practice, and (4) people. Furthermore, an organizational design strategy that consists of reusable components which are reconfigurable within a scalable framework can engender adaptability throughout the enterprise. Despite the value added to the agility literature, Dove's work still centers on manufacturing firms.

One of the first organizational-level (i.e., non-manufacturing related) agility definitions was proposed by Sambamurthy et al. (2003), who define agility as "the ability to detect opportunities for innovation and seize those competitive market opportunities by assembling

requisite assets, knowledge, and relationships with speed and surprise" (p. 245). They build on March's (1991) work by proposing that agility includes the exploration and exploitation of opportunities for market arbitrage. Similar definitions have followed, including Overby et al.'s (2006) definition of enterprise agility as "the ability of firms to sense environmental change and respond readily" (p. 121) and Van Oosterhout et al.'s (2006) definition of business agility as "being able to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage unpredictable external and internal changes" (p. 134).

Despite the nuanced differences between manufacturing agility and organizational agility, a number of key themes emerge from these various agility definitions. First, agility is best viewed as an organizational *capability*, i.e., a set of organizational routines and processes that produces a particular output, not as a static asset or resource. Hence, agility must be developed by the firm; it cannot be purchased from factor markets. Dove (2001) puts it nicely: "Agility does not come in a can" (p. 6). Second, agility implies *sense and response*. Prior research suggests that strong sensing capabilities and responding capabilities are critical to firm success in turbulent environments (Haeckel 1999; Zaheer and Zaheer 1997). Thus, any definition of organizational agility should emphasize the ability to sense and respond to environmental change, whether that change arises from competitors' actions, shifts in customer preferences, regulatory or legal changes, economic shifts, or technological advancements. Finally, agility is especially important in dynamic, fast-paced environments. Hence, the ability to sense and respond *quickly* is also important.

We also note that our review of the literature uncovered only one definition of customer agility. In particular, Sambamurthy et al. (2003) define customer agility as "the co-

opting of customers in the exploration and exploitation of opportunities for innovation and competitive action moves" (p. 245). The term "co-opt" is not clearly understood, as it could imply appropriate, assimilate, or win over. Furthermore, exploration and exploitation are broad categories which include numerous activities such as search, experimentation and refinement. As a result of these limitations, we propose a refined definition of customer agility that builds on the work of Sambamurthy et al. (2003). Based on our review of the agility literature, we modify this definition and propose the following: *customer agility is the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action*. Our definition includes key elements of agility identified earlier, including capability, sense and respond, and speed. By "customer-based" we refer to opportunities which originate from (1) individual customers, (2) discussions among customers or (3) interactions between customers and a representative of the focal firm. In the following section we review concepts similar to customer agility in the hopes of gaining a better understanding of our focal construct.

2.1.2 Distinguishing Customer Agility from Related Concepts

Based on the previous section, customer agility is defined as the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. This working definition allows us to see how customer agility builds upon and yet differentiates from related concepts; specifically, absorptive capacity, exploration/exploitation and market orientation. By reviewing concepts similar to customer agility, we gain deeper insight into 1) the underlying structure of customer agility and 2) characteristics of firms which have well-developed customer agility practices.

2.1.2.1 Absorptive Capacity

Absorptive capacity refers to the ability to identify, assimilate, transform, and apply external knowledge (Cohen and Levinthal 1990). Through its R&D activities, a firm develops collective knowledge about certain areas of markets, science and technology and how those areas relate to the firm's products and services (Cohen and Levinthal 1989). This knowledge base facilitates the firm's ability to identify and value external knowledge. Over time, the firm develops processes, policies and systems that facilitate sharing and transferring knowledge internally, which enables the ability to assimilate and transform external knowledge (Cohen and Levinthal 1990; Todorova and Durisin 2007). Firms apply their new knowledge to forecast technological trends (Cohen and Levinthal 1994) and create commercial and knowledge outputs, thereby increasing firm performance (Zahra and George 2002). Developing and maintaining absorptive capacity is "critical to a firm's long-term survival and success because absorptive capacity can reinforce, complement, or refocus the firm's knowledge base" (Lane et al. 2006, p. 833).

The identify, assimilate and transform dimensions of absorptive capacity refer to firms' ability to gather and absorb external knowledge. This is similar to the sensing component of customer agility. The apply dimension of absorptive capacity is similar to the responding component of customer agility in that they both relate to a firm's ability to use the newly assimilated or transformed knowledge. However, there are two key differences between absorptive capacity and customer agility. First, absorptive capacity refers predominantly to a firm's ability to manage knowledge, by identifying, assimilating, transforming, and applying it, whereas customer agility refers predominantly to a firm's ability to manage changes in customer preferences and needs, by sensing and responding to customers (Overby et al. 2006). Moreover,

by focusing on all of the firm's activities related to knowledge absorption, absorptive capacity is much broader in scope than customer agility, which covers only two dimensions - sensing and responding.

Second, absorptive capacity focuses on knowledge flows and application; customer agility encompasses not only knowledge but also the ability to mobilize a variety of resources and capabilities. Although the knowledge application dimension of absorptive capacity implies the use of resources and capabilities to apply assimilated knowledge, the greatest value of the absorptive capacity construct lies in its "front half," i.e., identify, assimilate and transform knowledge (Lane et al. 2006). Moreover, the ability to apply new knowledge does not necessarily equate to the ability to respond to external opportunities. An organization may excel at applying valuable external knowledge to improve its business processes, customer relations, or operations, yet these same processes must be efficient and effective in order to respond to opportunities for innovation and competitive action (Dove 2001). In this respect, absorptive capacity may be considered an antecedent to customer agility.

2.1.2.2 Exploration and Exploitation

Organizational learning theory is concerned with the development of insights, knowledge and associations between past actions, the effectiveness of those actions, and future actions (Huber 1991). Although the organizational learning literature is vast, recent reviews uncover a number of key concepts in the literature (Bapuji and Crossan 2004; Easterby-Smith et al. 2000). These concepts include exploration and exploitation (March 1991), learning across levels of analysis (Crossan et al. 1999), organizational memory (Walsh and Ungson 1991), single versus double loop learning (Argyris and Schon 1978), and unlearning (Hedberg 1981). One of

these concepts – exploration and exploitation – is related to the sensing and responding components of customer agility. In the following sections we discuss how customer agility builds upon, and yet is distinct from, exploration/exploitation.

Exploration and exploitation have emerged as the twin concepts supporting organizational learning research (Baum et al. 2000; Gupta et al. 2006; March 1991). Exploration refers to learning gained through processes of concerted variation, organizational experimentation with new alternatives, and quests for knowledge about unknown market opportunities. Exploitation refers to learning gained via local search, experiential refinement, and the use of existing knowledge, competencies and technologies.

Scholars working in this arena recognize that "the long-term survival of an organization depends on its ability to engage in enough exploitation to ensure the organization's current viability and engage in enough exploration to ensure its future viability" (Levinthal and March 1993, p. 105). However, even though both exploration and exploitation are essential for long-run adaptation (Benner and Tushman 2002; Levinthal and March 1993; March 1991), the two are fundamentally incompatible. In particular, the interplay between the two occurs in the form of a zero-sum game where exploration and exploitation each compete for scarce resources, attention and organizational routines (March 1991; 1996; 2006); accordingly, "logic dictates that exploration and exploitation be viewed as two ends of a continuum" (Gupta et al. 2006, p. 695).

The incompatibility between exploration and exploitation sets the stage for how these concepts are related to customer agility. Specifically, the two components of customer agility – sensing and responding – are related to but different from the concepts of exploration and exploitation. For instance, agile firms sense environmental change by exploring new

opportunities for innovation and competitive action. When these new opportunities are identified and assessed, firms respond by exploiting their existing capabilities and knowledge with speed and surprise. However, unlike exploration and exploitation, sensing and responding are not necessarily incompatible. With respect to competition for resources, sensing does not necessarily involve large commitments of resources, at least not relative to responding (Teece 2007). Certain aspects of exploration, such as scanning the environment, can be a low-cost activity (Hambrick 1982). Furthermore, early-stage research activities often account for only a small percentage of total new product development costs (Mansfield et al. 1971). Also, the tensions arising from different mindsets and routines can be mitigated by having different organizational units specializing to some degree on sensing as compared to responding (i.e., structural ambidexterity, Benner and Tushman 2003; Duncan 1976). As an alternative, business units may be able to put management systems in place that allow them to simultaneously sense and respond to changes in the external environment (Gibson and Birkinshaw 2004).

Finally, from a process perspective, responding follows sensing, i.e., a firm must sense a change, problem, or opportunity before it can respond (Haeckel 1999); on the other hand, exploitation (the corollary to responding) does not necessarily follow exploration (a firm may produce multiple, consecutive exploitative innovations). This also implies that exploration and exploitation are "states" in which a firm operates, i.e., a firm undertakes explorative or exploitative activities on a continuous basis. On the other hand, sensing and responding are more "event" based; specifically, they consist of activities triggered by events in the environment (e.g., detected opportunities, rival competitive action). Thus, sensing and responding overlap yet are distinct from exploration and exploitation.

2.1.2.3 Market Orientation

Market orientation has been viewed from two vantage points: as an organizational culture and as a set of information processing activities. With respect to the former, market orientation is defined as the extent to which an organizational culture is devoted to meeting customers' needs and outfoxing competitors (Narver and Slater 1990). From an information processing perspective, market orientation refers to the extent to which organizations generate, disseminate and respond to market intelligence pertaining to current and future customer needs (Kohli and Jaworski 1990). Market intelligence includes information about customers, competitors and other factors such as technology and regulatory developments.

The information processing view of market orientation shares some similarity to customer agility. Both concepts explicitly include responsiveness to customer preferences and market intelligence. However, market orientation is heavily rooted in information processing (e.g., information is gathered, disseminated and acted upon); on the other hand, customer agility is not necessarily as reliant on information processing. For example, it is possible for firms to act with agility without disseminating information across departments (Overby et al. 2006). Yet these similarities imply that market-oriented firms are likely to exhibit high levels of customer agility. In contrast to the broad concepts of absorptive capacity and exploration/exploitation, market orientation and customer agility are similar in that they both pay particular attention to the customer-firm relationship (Day 1994). As a result, we investigate research in which market orientation has been linked to firm performance and organizational responsiveness.

In a synthesis of the "culture" and "information processing" views of market orientation, Hult et al. (2005) conceptualize and test a model linking market orientation (as culture) and market information processing activities (as defined by Kohli and Jaworski 1990) to organizational responsiveness, which is subsequently linked to firm performance. Their findings show that a market-oriented organizational culture combined with market-oriented information processing capabilities enables the firm to respond more quickly to environmental activities, e.g., shifts in customer preferences, competitor behavior, thereby enhancing firm performance. In addition to facilitating the firm's response capability, a market-oriented culture emphasizing learning and participative decision making fosters the organization's level of innovativeness (Hurley and Hult 1998).

Marketing scholars have linked market orientation to customer response capability. Jayachandran et al. (2004) define customer response capability as "the competence of an organization in serving customer needs through effective and quick actions" (p. 220). Specifically, customer response capability is divided into two dimensions: customer response expertise, the extent to which an organization's responses effectively meet customer needs, and customer response speed, the extent to which the organization's responses to customer needs are rapid. Empirical evidence shows that organizational activities that focus on the generation, analysis and dissemination of customer-related information are positively related to customer response capability (Jayachandran et al. 2004). Building on this work, Homburg et al. (2007) find that cognitive (information) and affective (cultural) organizational systems positively impact both customer-related and competitor-related responsiveness. Recent meta-analyses find that market orientation has a positive impact on firm performance, innovativeness, customer loyalty,

and quality (Cano et al. 2004; Kirca et al. 2005). This review of the literature shows us that market-oriented firms are likely to exhibit high levels of customer agility.

2.1.2.4 Summary

Our review finds that customer agility overlaps with absorptive capacity, exploration/exploitation and market orientation, thereby allowing us to leverage their rich underlying theoretical perspectives and research streams (e.g., Cohen and Levinthal 1990; Kohli and Jaworski 1990; March 1991). Yet we also find that customer agility emerges as a distinct construct. For instance, absorptive capacity is a broad construct that addresses how well a firm identifies, assimilates, transforms, and applies knowledge to create new commercial and knowledge outputs. In contrast to this encompassing view, customer agility focuses on the firm's relationship with current and potential future customers. Moreover, customer agility refers to the firm's ability to manage changes in customer preferences and needs, not necessarily customer knowledge.

Similarly, while exploration is analogous to sensing and exploitation is akin to responding, there are subtle differences at play. First, exploration and exploitation are logically incompatible; sensing and responding are not incompatible. Also, from a process perspective, responding follows sensing, i.e., a firm must sense a change, problem, or opportunity before it can respond (Haeckel 1999); on the other hand, exploitation, the corollary to responding, does not necessarily follow exploration.

Market orientation research shows us that market oriented firms tend to have a higher rate of responsiveness to customer-based and market-generated intelligence than non-market oriented firms. Hence, the fundamental information processing activities underlying market

orientation (i.e., the organization-wide generation and dissemination of market intelligence) are salient to customer agility. While market orientation includes the dissemination of market intelligence across organizational units, a firm may be agile in its customer practices without necessarily disseminating vast quantities of information. Table 2.2 synthesizes our review of concepts related to customer agility. The next section situates customer agility within the role of the firm.

Table 2.2. Customer Agility and Related Concepts

Concept	Overlap with Customer Agility	Distinction from Customer Agility	Contribution to our Understanding of Customer Agility	Supporting Literature
Absorptive Capacity	The knowledge identification component of absorptive capacity overlaps with customer sensing capability, and knowledge application overlaps with customer responding capability.	Customer agility refers to the firm's ability to manage changes in customer preferences and needs, not necessarily customer knowledge.	Absorptive capacity will facilitate the firm's ability to sense customer-based opportunities for innovation; hence, absorptive capacity may be an antecedent to customer agility.	(Cohen and Levinthal 1990; Lane et al. 2006; Todorova and Durisin 2007; Zahra and George 2002)
Exploration / Exploitation	Agile firms sense environmental change by exploring new opportunities for innovation and competitive action. In turn, firms respond to these opportunities by exploiting their existing capabilities with speed and surprise.	Exploration and exploitation are logically incompatible; sensing and responding are not necessarily incompatible. Also, a response must follow some type of sensing activity; on the other hand, exploitation does not necessarily follow exploration.	Maintaining a balance between exploration and exploitation is critical to organizational adaptation in the long run. Similarly, firms must be able to quickly sense and respond to market opportunities if they are to survive in dynamic environments.	(Baum et al. 2000; Benner and Tushman 2003; Gupta et al. 2006; Levinthal and March 1993; March 1991; 1996)
Market Orientation	Market intelligence generation overlaps with customer sensing capability. Moreover, both concepts include responsiveness to market intelligence.	While market-oriented firms are likely to be "customer agile," firms may be agile without necessarily disseminating information across subunits.	Market-oriented firms are likely to be "customer agile;" thus, it is important to understand their characteristics (i.e., policies and practices).	(Day 1994; Homburg et al. 2007; Hult et al. 2005; Kohli and Jaworski 1990; Sinkula 1994)

2.2 Situating Customer Agility in the Role of the Firm

The previous section provided insight into the basic structure of customer agility. However, we still lack a deeper understanding of customer agility, in particular its sensing and responding components. Furthermore, we do not yet know the drivers and outcomes of customer agility. Thus, in this section we situate customer agility in three organizational perspectives: 1) dynamic capabilities, 2) capability alignment and 3) competitive dynamics. By doing so we aim to arrive at a richer conceptualization of customer agility and its potential antecedents and consequences. Following this we examine the unique role of IT in the nomological net surrounding customer agility.

2.2.1 Dynamic Capabilities

In this section we aim to achieve three goals. First, we describe dynamic capabilities, a research stream which has recently witnessed insightful yet often contradictory conceptualizations and empirical findings. Following this, we conceptualize customer agility as a dynamic capability, focusing in particular on the nature of its sensing and responding components. Finally, we uncover salient antecedents of customer agility. In particular, knowledge-based factors enhance customer sensing capability, and process-based factors enhance customer responding capability.

2.2.1.1 Dynamic Capabilities: Overview

The dynamic capabilities literature is grounded in the evolutionary theory of the firm (Nelson and Winter 1982). Since managers make decisions under uncertainty and are boundedly rational, they 'satisfice' rather than optimize in searching for and selecting solutions to problems (March and Simon 1958). The implication is that firms should continually reconfigure their

existing capabilities. Firms are especially challenged to revise their routines when faced with dynamic or unpredictable environments (Eisenhardt and Martin 2000; March 1991). The new routines form the foundation of firms' knowledge bases (Zollo and Winter 2002). However, along with these new capabilities, the firm "also develops the capacity to change routines and integrate them into their operations" (Zahra et al. 2006, p. 921).

Before discussing dynamic capabilities, it is important to distinguish resources from capabilities. A resource is an asset or input to production that a firm owns, controls, or has access to on a semi-permanent basis (Helfat and Peteraf 2003). Examples of resources include manufacturing materials, research and development skills, and computer hardware. An organizational capability is a high-level routine or set of routines that confers upon an organization's management a set of decision options for producing significant outputs of a particular type (Winter 2003). For instance, resource divestment refers to the capacity to dispose of an asset from the firm's portfolio and the associated factor market transfer of that resource to another firm (Moliterno and Wiersema 2007).

Dynamic capabilities are distinguished from substantive ('ordinary') organizational capabilities in that dynamic capabilities refer to the ability to change or reconfigure existing substantive capabilities (Collis 1994). For instance, a new routine for product development is a new substantive capability, but the ability to change such capabilities is a dynamic capability. Other examples of dynamic capabilities include absorptive capacity (Zahra and George 2002), adaptive capability (Rindova and Kotha 2001), knowledge transfer (Szulanski 1996), and strategic decision making (Eisenhardt 1989). Despite the theoretical and practical importance of dynamic capabilities to a firm's competitive advantage (Eisenhardt and Martin 2000; Teece et al.

1997), the dynamic capabilities literature contains contradictions and inconsistencies (Zahra et al. 2006) and is criticized for a lack of empirical grounding (Williamson 1999). For instance, there are numerous and often conflicting definitions of dynamic capabilities (see Table 2.3).

Table 2.3. Key Definitions of Dynamic Capabilities

Source	Definition
Helfat (1997)	The subset of the competences/capabilities which allow the firm to create new products and processes and respond to changing market circumstances.
Teece et al. (1997)	The firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.
Eisenhardt and Martin (2000)	The firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources – to match or even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resources configurations as markets emerge, collide, split, evolve and die.
Zahra and George (2002)	Dynamic capabilities are essentially change-oriented capabilities that help firms redeploy and reconfigure their resource base to meet evolving customer demands and competitor strategies.
Zollo and Winter (2002)	A dynamic capability is a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness.
Winter (2003)	Those that operate to extend, modify or create ordinary (substantive) capabilities.
Zahra et al. (2006)	The abilities to reconfigure a firm's resources and routines in the manner envisioned and deemed appropriate by its principal decision-maker(s).
Helfat et al. (2007)	The capacity of an organization to purposefully create, extend, or modify its resource base.
Teece (2007)	Dynamic capabilities can be disaggregated into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets.
Wang and Ahmed (2007)	A firm's behavioral orientation constantly to integrate, reconfigure, renew and recreate its resources and capabilities and, most importantly, upgrade and reconstruct its core capabilities in response to the changing environment to attain and sustain competitive advantage.

Taking into account these various definitions of dynamic capability, we define dynamic capability as "*the capacity of an organization to purposefully create, extend, or modify its resource base*" (Helfat et al. 2007, p. 4, emphasis in original). This definition is precise enough to be meaningful, yet broad enough to allow researchers to examine more about the nature and origins of dynamic capabilities (Easterby-Smith et al. 2009). The "resource base" of an organization includes tangible, intangible, and human assets as well as organizational capabilities. The term "capacity" refers to the ability to perform a task or set of tasks in at least a minimally acceptable manner. This also implies that the function that a dynamic capability performs is a repeatable and relatively stable activity. Finally, the word "purposefully" indicates that dynamic capabilities reflect some degree of intent, even if not fully explicit. As a result, dynamic capabilities are distinguished from organizational routines, which consist of rote organizational activities that lack intent (Dosi et al. 2000).

The effect of dynamic capabilities on the creation, extension and modification of a firm's resource base varies with environmental dynamism. A key underlying assumption is that developing and maintaining a dynamic capability requires a commitment of resources, i.e., it is costly to maintain (Winter 2003). When the environment is stable or moderately dynamic, developing and maintaining dynamic capabilities may not be a worthwhile effort because there is no need to change existing substantive capabilities or respond to market opportunities. To put it succinctly, "To have a dynamic capability and find no occasion for change is merely to carry a cost burden" (Winter 2003, p. 993). In contrast, in high-velocity environments where industry structure breaks down, dynamic capabilities are needed to reconfigure substantive capabilities in response to environmental disruptions (Brown and Eisenhardt 1997; Eisenhardt and Martin

2000). For instance, the impact of dynamic capabilities on functional competencies in new product development is positively moderated by environmental turbulence (Pavlou and El Sawy 2006). Thus, the key takeaway is that environmental dynamism increases the value potential of dynamic capabilities.

We note that it is quite possible for organizations to change without exercising a dynamic capability. For instance, ad hoc problem solving is one mechanism by which managers react to change (Winter 2003). While a dynamic capability is a relatively stable activity, ad hoc problem solving is not routine, highly patterned or repetitious. In fact, the "relatively stable" aspect of dynamic capabilities implies that all dynamic capabilities are inherently limited in their rate of dynamization (Schreyogg and Kliesch-Eberl 2007).

2.2.1.2 Customer Agility as Dynamic Capability

In a review of the dynamic capability literature, Teece (2007) disaggregates dynamic capabilities into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities and (3) to maintain competitiveness through enhancing, combining and reconfiguring the firm's intangible and tangible assets. Figure 2.1 displays Teece's framework.

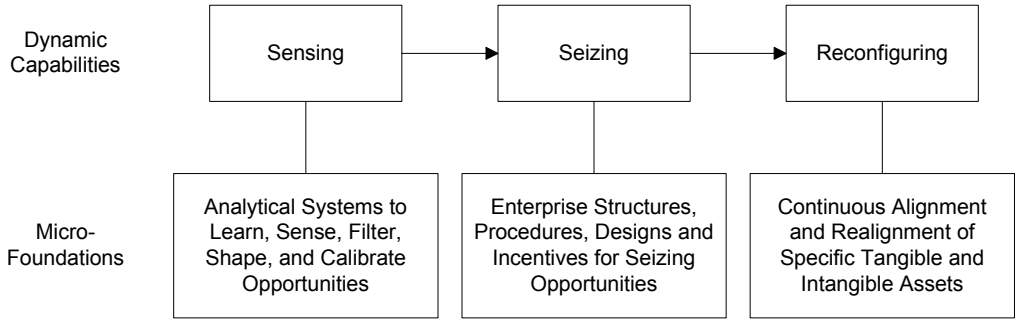


Figure 2.1. Micro-Foundations of Dynamic Capabilities (adapted from Teece 2007)

Based on our working definition, agility captures the sensing and seizing components of dynamic capabilities in Teece's (2007) framework. Specifically, customer agility refers to the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. Hence, we conceptualize customer agility as a dynamic capability enabled by key organizational micro-foundations.

While the sensing and seizing components of Teece's model are applied in a fairly straightforward manner to customer agility, Teece's third component – reconfiguring – is outside the scope of customer agility. Reconfiguration of capabilities and resources is required to effectively adapt to and evolve with environmental changes, whether they be threats or opportunities (Teece 2007). Moreover, reconfiguration requires the continuous alignment and realignment of specific tangible and intangible assets. There are numerous mechanisms by which firms reconfigure their capabilities, including capability substitution, capability evolution and capability transformation (Lavie 2006). While an agile firm may excel at capability reconfiguration, agility characterizes only the firm's ability to sense and respond to environmental change (Haeckel 1999; Sambamurthy et al. 2003). Hence, we do not investigate capability reconfiguration in this study.

Sensing new opportunities is very much a scanning, creation, learning, and interpretive activity (Teece 2007). To identify and shape opportunities, firms must constantly search and explore across technologies and markets, both local and distant (Benner and Tushman 2003; March 1991; Nelson and Winter 1982). Sensing processes follow the typical sequence of information processing activities that firms use to learn (Crossan et al. 1999; Huber 1991; Levitt and March 1988). For example, sensing activities involve investing in research activities, probing

customer needs, understanding latent demand, and assessing likely supplier and competitor responses (Teece et al. 1997).

Once an opportunity for innovation or competitive action is sensed, it must be addressed by mobilizing the firm's existing processes or services. In essence, a firm's responding capability is basically its physical ability to act (Dove 2001). Responding to opportunities involves maintaining and developing technological resources and complementary assets and then, when the time is right, investing heavily in the particular technologies and designs most likely to achieve marketplace acceptance (Teece 2007).

2.2.1.3 Enhancing Customer Agility Through Knowledge and Process

Scholars propose that the firm's ability to sense market opportunities depends on its ability to create and leverage knowledge (Haeckel 1999; Overby et al. 2006; Sambamurthy et al. 2003). For example, organizational systems that identify target market segments, changing customer needs and customer-based innovation should strengthen the firm's customer sensing capability (Teece 2007). Further, analytical tools will also aid managers who are trying to find patterns and make sense of large volumes of customer-related information (Davenport and Harris 2007). This study adopts this view by integrating "knowledge-based" constructs as antecedents to customer sensing capability in the research model.

Scholars propose that the firm's ability to respond to market opportunities depends on the coordination and flexibility of its products and processes (Dove 2001). For instance, by speeding the flow of information and reducing potential bottlenecks, well-coordinated organizational processes and routines will enable the firm to quickly respond to opportunities (Malone and Crowston 1994). The firm's response capability may also be enhanced by effective

coordination with its channel partners (Mohr and Nevin 1990). Hence, we conceptualize "process-based" constructs as antecedents to customer responding capability in our research model. Figure 2.2 provides a high-level view of the relationships among knowledge, process, sensing, and responding. In the next section we draw upon the strategic alignment literature to determine potential relationships between customer sensing capability and customer responding capability.

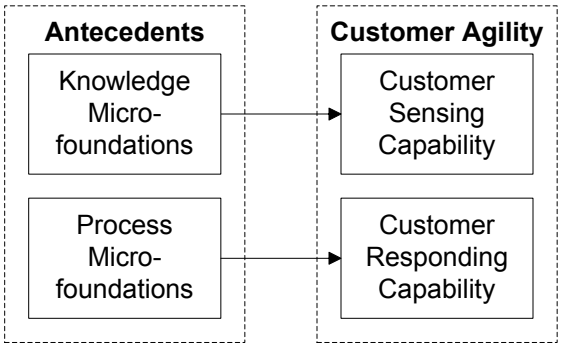


Figure 2.2. Antecedents to Customer Agility

2.2.2 Capability Alignment

The concept of "fit" remains one of the most enduring in the management field (Zajac et al. 2000). The notion of fit suggests an alignment among things internal to a firm, such as strategy and structure (Chandler 1962) or strategy and organizational activities (Porter 1996). It also suggests external alignment, such as organizational structure with the contextual environment (Burns and Stalker 1961; Lawrence and Lorsch 1967). A key proposition is that both internal and external fit enhance firm performance. A stronger view is that strategic fit may provide a basis for sustainable competitive advantage (Miller 1996; Porter 1996; Rivkin 2000).

Using a contingency theoretic perspective, a long stream of research supports a connection between internal alignment and superior firm performance (Govindarajan 1988; Gupta and Govindarajan 1984; Khandwalla 1973; Whittington et al. 1999). Although contingency theory has been widely criticized for a number of theoretical and methodological limitations (Mohr 1982; Schoonhoven 1981; Van de Ven and Drazin 1985), a number of recent developments have stimulated a renewed academic interest in fit and the contingency perspective. One major factor is the increasing attention commanded by economists' work on complementarities among elements of a firm's strategy (Milgrom and Roberts 1990; 1995). By rigorously modeling mutually reinforcing interactions within a mathematical framework, "this work has helped to legitimate the concept of fit, particularly internal fit" (Peteraf and Reed 2007, p. 1093). Recent work on organizational adaptation along rugged fitness landscapes (Levinthal 1997) has also helped legitimate the concept of fit. In particular, this line of organizational adaptation research has contributed new insights regarding interaction effects to the contingency perspective (Levinthal 1997; Rivkin and Siggelkow 2003).

Researchers working in the dynamic capabilities arena have built on the strategic alignment (i.e., fit) literature. In particular, a critical aspect of fit emphasized in the dynamic capabilities framework is co-specialization (Teece 1986; Teece et al. 1997). For instance, asset orchestration is a key dynamic capability that allows managers to assemble and orchestrate co-specialized assets to create superior firm performance (Helfat et al. 2007). Managing internal fit over time is a key dynamic capability (Adner and Helfat 2003; Siggelkow 2002). Managers who achieved internal alignment between the overall set of administrative practices and the

activities implied by the organizational choice set during a period of deregulation in the airline industry experienced measurable efficiency gains (Peteraf and Reed 2007).

With respect to customer agility, scholars argue that sensing and responding capabilities need to be simultaneously developed and applied in order for firms to reap the benefits of agility (Haeckel 1999; Overby et al. 2006; Teece 2007). A strong customer sensing capability may be wasted if a firm lacks the ability to respond to identified opportunities, and a strong responding capability may not help a firm if it is unable to identify opportunities on which to act. Despite the importance of "good fit" between customer sensing capability and customer responding capability, prior research has not thoroughly considered the many ways in which these two capabilities can or should fit each other. In this section we compare and contrast a number of perspectives of agility alignment.

When considering the most appropriate perspective of fit for a given research question, researchers recommend considering multiple specifications as competing theories or models, especially in cases in which the extant research may not be strong enough to guide current research (Tosi and Slocum 1984; Venkatraman 1989b). Van de Ven and Drazin (1985) recommend that "studies should be designed to permit comparative evaluation of as many forms of fit as possible… Examining multiple approaches to fit in contingency studies and relating the findings to unique sample characteristics can greatly aid the development of mid-range theories of what approaches to fit apply where" (pp. 358-360). Venkatraman (1989b) proposes three perspectives of fit when two variables are involved: moderation, matching and mediation. Hence, we investigate the fit between customer sensing capability and customer

responding capability in terms of these three perspectives. In doing so we hope to uncover insightful nuances of the nature of customer agility that otherwise may not have been noticed.

2.2.2.1 Alignment as Moderation

According to the moderation perspective, the impact that a predictor variable has on a criterion variable is dependent on the level of a third variable (i.e., the moderator) (Venkatraman 1989b). The fit between the predictor and the moderator is the primary determinant of the criterion variable. When applied to customer agility, it is important to note that a firm's competitive activity, our criterion variable of interest, is manifested through its customer responding capability. Hence, the impact of customer responding capability (the predictor) on competitive activity varies across the different levels of customer sensing capability (the moderator; see Figure 2.3).

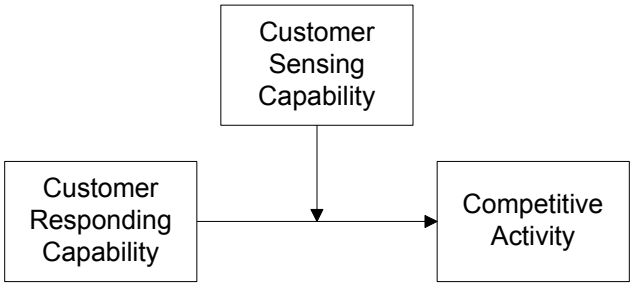


Figure 2.3. A Moderation Perspective of Agility Alignment

To gain a better understanding of the moderation perspective, let us consider two direct competitors: Firm A and Firm B. Firm A has a stronger customer sensing capability than Firm B; thus, Firm A is able to sense more customer-based opportunities than Firm B. Let us suppose that, over a period of one year, Firm A senses ten opportunities, and Firm B senses only five opportunities. By sensing more opportunities, Firm A is more likely to implement its customer

responding capability and take more competitive action. Thus, the relationship between customer responding capability and competitive activity would be stronger when customer sensing capability is high.

2.2.2.2 Alignment as Matching

The matching perspective is used for concepts in which fit is a theoretically defined match between two related variables. In contrast to the moderation perspective, the matching perspective specifies fit without reference to a criterion variable, although its effect on a set of criterion variables could be examined (Venkatraman 1989b). The basic premise is that the stronger the match between customer sensing capability and customer responding capability, the greater the effect of customer agility on an appropriate criterion variable. Overby et al. (2006) provide a "matching" framework for the different combinations of sensing and responding capabilities that firms may possess (see Table 2.4). We apply this framework in the context of customer agility.

Table 2.4. Different Combinations of Sensing and Responding Capabilities

Quadrant I: High Sensing, High Responding Strong capabilities in R&D, information processing, market intelligence, etc. allow the firm to sense market opportunities. Strong capabilities in product development, interfunctional coordination, supply chain, etc. allow the firm to quickly respond to market opportunities.	**Quadrant II: High Sensing, Low Responding** The firm might be able to sense change relevant to their business activities but fail to respond to it in an agile manner. A weak responding capability may be due to poor conflict resolution, 'analysis paralysis', or an inability to mobilize resources.
Quadrant III: Low Sensing, High Responding Strong capabilities in product development, interfunctional coordination, supply chain, etc. allow the firm to quickly respond to market opportunities. However, the firm misses emerging market opportunities because it is unable to sense relevant change.	**Quadrant IV: Low Sensing, Low Responding** The firm lacks the ability to sense relevant change and the ability to quickly respond to market opportunities.

Quadrant I characterizes firms that have high customer sensing capability and high customer responding capability. These firms have strong sensing capabilities supported by R&D, information processing, market intelligence, and other knowledge-enhancing capabilities. Additionally, these firms have strong responding capabilities enhanced by product development, interfunctional coordination, supply chain, and other process-enhancing capabilities. For example, BMW senses emerging customer needs by involving lead users in the generation of ideas toward its product innovation activities, and they also respond quickly by implementing valuable ideas in future products (Prandelli et al. 2006).

Quadrant II includes firms that are able to sense change relevant to their business activities (high sensing capability) but fail to respond to it in an agile manner (low responding capability). For example, these firms might fail to resolve conflicts in a timely manner, thereby slowing down the strategic decision making process (Eisenhardt 1989). In the 1970s, Xerox

sensed impending changes in the computing industry and developed multiple computing innovations; however, for a number of reasons Xerox failed to bring these innovations to market. Although Xerox was able to sense shifts in customer demand, it was unable to respond quickly to those opportunities (Alexander and Smith 1988).

Firms which have a low sensing capability and a high responding capability are categorized into Quadrant III. Although these firms are able to quickly respond to market opportunities, they usually fail to sense these opportunities or sense the wrong opportunities. This lack of a sensing capability may be due to several factors. For instance, firms must have prior related knowledge in a particular area in order to make sense of new developments in that area (Cohen and Levinthal 1990). Apple's introduction of the Newton, a personal digital assistant (PDA), provides a nice illustration of low sensing and high responding. Apple positioned the Newton as a mass-market product when, in fact, it was too early in its development for the Newton to be made generally available. As a result, the Newton lost its audience and never again gained traction in the PDA market (Bayus et al. 1997).

Finally, Quadrant IV includes firms that have low sensing capability and low responding capability. In the 1980s, Digital Equipment Corporation failed to sense and respond to emerging markets for microcomputers and personal computers (Verity 1992). Its pursuit of a sustainable advantage in minicomputers may have blinded it to the rapid changes going on in the hypercompetitive computer industry (D'Aveni 1994).

2.2.2.3 Alignment as Mediation

The mediation perspective specifies the existence of a significant intervening mechanism between an antecedent variable and the dependent variable (Venkatraman 1989b).

Like moderation, the mediation perspective is anchored with respect to a particular criterion variable. However, by viewing the functional form of fit as simply indirect effects, the mediation perspective is less precise than the moderation perspective (Venkatraman 1989b). Despite this limitation, the mediation perspective does provide researchers with the ability to recognize differences in the various stages of a system of relationships. For example, market share mediates the relationship between firm strategy and firm profitability across different environmental contexts (Prescott et al. 1986).

Teece (2007) proposes a rationale for the mediation perspective behind agility. Based on Figure 2.1, Teece (2007) argues, "An enterprise's ability to manage competitor threats and to reconfigure itself is dependent on its investment activity, which is in turn dependent on its ability to sense an opportunity... The likelihood of achieving financial success depends on events and responses to them" (p. 1343). When applied to our study, a firm's ability to take competitive action is dependent on its ability to respond to market opportunities. In turn, a firm's ability to respond is inherently dependent on its ability to sense opportunities. Based on this reasoning, customer responding capability mediates the relationship between customer sensing capability and competitive activity (see Figure 2.4).

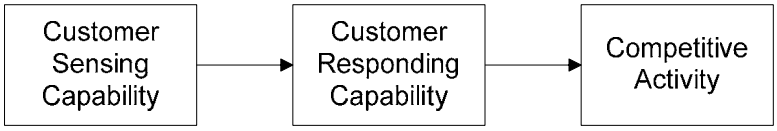


Figure 2.4. A Mediation Perspective of Agility Alignment

Table 2.5 details differences between the moderation, matching and mediation perspectives of fit with respect to customer agility. We discuss analytic (statistical) issues behind agility alignment in Chapter 4.

Table 2.5. Applying Perspectives of Fit to Customer Agility

Fit Perspective	Description	Application to Customer Agility
Moderation	The impact that a predictor variable has on a criterion variable is dependent on the level of a third variable (i.e., the moderator)	The impact of customer responding capability on competitive activity varies across different levels of customer sensing capability
Matching	Fit is a theoretically defined match between two related variables	A strong customer sensing capability may be wasted if a firm lacks the ability to respond to identified opportunities, and a strong responding capability may not help a firm if it is unable to identify opportunities on which to act
Mediation	An intervening mechanism mediates the relationship between an antecedent variable and the dependent variable	Customer responding capability mediates the relationship between customer sensing capability and competitive activity

Although we have uncovered the relationships surrounding knowledge, process, sensing, and responding capabilities, we have not yet investigated potential consequences of customer agility. To do so we turn to the competitive dynamics literature.

2.2.3 Competitive Dynamics

In this section we review the competitive dynamics literature to formulate a link between customer agility and a relevant outcome variable. Competitive dynamics research is concerned with how firm action affects competitors, competitive advantage and performance. We first discuss how competitive action is critical in contemporary hypercompetitive environments, especially in that action relates to future performance outcomes. Second, we

situate customer agility within the competitive dynamics framework. Finally, we review a range of competitive activity conceptualizations and measures to gain a better understanding of our ultimate outcome of interest.

2.2.3.1 Competitive Dynamics: Overview

Hypercompetitive environments are often described by images of war and paradox (Aupperle 1996; Ilinitch et al. 1996). For instance, Boeing managers consider themselves in a "death struggle with competitors" (Taylor 1995). In the mid-1980s, the Japanese beer wars brought about radical change by (1) witnessing a tenfold increase in the beer industry's new product introduction rate, (2) producing a major disruption in firms' competitive positions, and (3) forcing firms to transform themselves in fundamental ways in order to compete effectively (Craig 1996). Leading firms facing hypercompetitive conditions are also more likely to "eat their own lunch before someone else does," i.e., firms with a leading position are often not afraid to aggressively cannibalize their own existing advantages with next-generation advantages before competitors move in to steal the market (Nault and Vandenbosch 1996).

Firms operating in these cannibalistic, war-like environments must constantly undertake actions and reactions in order to survive and continuously recreate competitive advantage (D'Aveni 1994). These action/reaction dynamics reflect the normal and innovative movement of firms in pursuit of profits. Firms act creatively when they introduce new products, promotions, or services to enhance profits, competitive advantage and industry position. Successful actions promote competitive reaction as rivals attempt to block or imitate the action (Smith et al. 2001). Thus, research in competitive dynamics attempts to understand how and why firms undertake

actions to (1) create competitive advantage and (2) disrupt existing conceptualizations about the industry (Chen 1996; Miller and Chen 1996).

An underlying assumption is that competitive actions mediate the relationship between firms' capabilities and financial performance (Young et al. 1996). Researchers have empirically found that firms that are more active than their rivals improve their competitive positions (Ferrier et al. 1999) and increase their performance (Ferrier 2001; Young et al. 1996). On the other hand, firms that are slower than their rivals experience negative performance results (Miller and Chen 1994). The underlying logic is that more active firms achieve greater performance because they have greater aspiration levels, are more capable at implementing actions, and are perceived by rivals as more aggressive competitors than are less active firms (Smith et al. 2001). Hence, firms with more competitive activity will have superior performance over time in relation to rivals with less activity (D'Aveni 1994; Ferrier et al. 1999).

2.2.3.2 Customer Agility and Competitive Dynamics

There are three implicit yet essential organizational characteristics that influence competitive action (Chen 1996). These include (1) organizational factors that influence the *awareness* of the context and potential opportunities for innovation, (2) factors which enhance or inhibit the *motivation* of firms to take action and (3) resource-based factors which influence the firm's *ability* to take action. The awareness component is related to customer sensing capability, and the ability aspect is related to customer responding capability. Thus, competitive activity measures how well a firm senses and responds to customer-based opportunities for innovation and competitive action (Sambamurthy et al. 2003). We note that the motivation factor often stems from environmental conditions. For instance, industry characteristics (e.g.,

barriers to entry, regulatory standards) will often impact a firm's competitive nature (Ferrier 2001; Young et al. 1996). Hence, while a sensed opportunity may motivate the firm to take action, generally speaking the motivation factor is outside the scope of this study. Figure 2.5 maps customer agility onto the competitive dynamics theoretical framework.

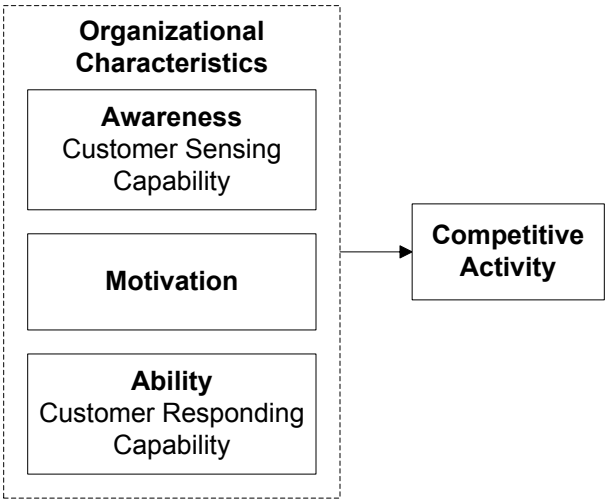


Figure 2.5. The Role of Customer Agility in Competitive Dynamics

Researchers have investigated several important organizational level characteristics that may influence the firm's awareness, motivation and/or ability to carry out action. These characteristics include organizational size (Chen and Hambrick 1995), structural complexity (Smith et al. 1991), organizational age (Miller and Chen 1996), market dependence (Chen and MacMillan 1992), past performance (Hambrick et al. 1996), reputation (Smith et al. 1992), and top management team characteristics (Ferrier 2001). Despite the established acceptance of the awareness, motivation and ability framework in the competitive dynamics literature (Chen et al. 2007; Ketchen et al. 2004; Smith et al. 2001), no prior work has tested the relationship between agility and competitive activity. This may be due to the fact that much of the empirical

competitive dynamics research has been conducted using structured content analysis (Duriau et al. 2007; Smith et al. 2001), a method which relies on secondary data (Shapiro and Markoff 1997). Since agility may be quite difficult to capture with secondary data, the methodological challenge in linking agility to competitive activity has not yet been taken up.

2.2.3.3 Conceptualizing Competitive Activity

It is important to note that rapid, simultaneous product introductions may have a negative impact on firm performance (Barnett and Freeman 2001). Competitive dynamics researchers have recognized this dilemma by conceptualizing and measuring various aspects of competitive activity, such as action repertoire complexity and rival action speed. Action repertoire complexity refers to the diversity of action types, e.g., pricing, marketing, product related actions, which are executed in a given time period (Miller and Chen 1996). Firms that take more diverse actions may achieve superior performance because diverse actions enable them to generate more unique advantages, which may be more difficult for competitors to imitate and compete away. Thus, while competitive activity is often considered to be a "good" thing, capturing multiple conceptualizations and measures of competitive activity creates a richer view of organizational phenomena in the competitive dynamics arena. Table 2.6 describes existing conceptualizations and measures of competitive activity.

Table 2.6. Conceptualizations and Measures of Competitive Activity

Conceptualization	Description	Reference
Action Volume	The total number of competitive actions carried out by a firm in a given time period	(Young et al. 1996)
Attack Duration	The time elapsed from the beginning to the end of a sequence of action events	(Ferrier 2001)

Conceptualization	Description	Reference
Attack Unpredictability	The extent to which a firm's sequential order of competitive actions is dissimilar from one attack period to the next	(Ferrier 2001)
Action Repertoire Complexity	The extent to which a firm concentrates on carrying out a broad range of action types in a given time period, as opposed to a narrow range of action types	(Miller and Chen 1996)
Action Execution Speed	The average amount of time that a firm spent to execute an announced action	(Chen and Hambrick 1995)
Action Visibility	The average amount of information available about a competitive action that a firm initiated	(Chen and Hambrick 1995)
Action Timing	The time elapsed between the date of a competitive action carried out by the market leader and the date of a preceding competitive action carried out by the challenger	(Ferrier 2001)

The key takeaway is that competitive activity measures how well a firm senses and responds to customer-based opportunities for innovation and competitive action (Sambamurthy et al. 2003). Furthermore, taking multiple conceptualizations and measures of competitive activity into account provides greater understanding. We adopt this perspective by integrating competitive activity as our ultimate outcome of interest as opposed to firm performance or competitive advantage. In the next section we investigate the role of IT as a key facilitator of customer agility and competitive activity.

2.2.4 The Role of IT

IS researchers have long been concerned with determining how and why IT creates business value, e.g., improves firm performance, productivity, competitive advantage (Bharadwaj 2000; Brynjolfsson and Hitt 2000; Hitt and Brynjolfsson 1996; Melville et al. 2004). Customer agility has been proposed as one of many IT-based value outcomes (Sambamurthy et al. 2003). In this section we review two subsets of the IT business value research: resource-

based value and digital options. These two streams are key to understanding how IT facilitates customer agility.

2.2.4.1 Resource-Based View of the Firm

A substantial portion of the IT business value literature is based on the resource-based view of the firm (RBV). The RBV conceptualizes business enterprises as portfolios of idiosyncratic resources (Penrose 1959; Wernerfelt 1984). Competitive advantage can flow at a point in time from the deployment and use of valuable, rare and inimitable resources and capabilities that might be heterogeneously distributed across firms (Barney 1991). More specifically, resources that are valuable and rare can lead to the creation of competitive advantage. This advantage can be sustained over longer time periods so long as the firm is able to protect against resource imitation, transfer or substitution. The RBV has received substantial empirical support in the extant organizational literature (Barney and Arikan 2001; Newbert 2007).

According to the RBV, firms leverage two distinct strategic mechanisms: resource-picking and capability-building (Makadok 2001). Resource-picking mechanisms create economic rents when firms apply superior information and knowledge to gain advantage from resources in the marketplace (Barney 1986). Firms that have superior knowledge capabilities perform better on acquiring resources and building capabilities (Grant 1996). Capability-building refers to the ability of firms to build unique capabilities that can leverage their resources (Teece et al. 1997). These embedded capabilities make them relatively more valuable and inimitable, thereby making them superior to resources as determinants of long-term performance.

Within the IS field, researchers have leveraged the RBV to investigate the conditions under which IT creates value. A principal finding is that IT capabilities and resources create value

when they operate in a synergistic manner with complimentary organizational capabilities and resources (Melville et al. 2004; Wade and Hulland 2004). These synergies may arise from IT's indirect (mediating) or interactive (moderating) effect on value creation (Kohli and Grover 2008). This is seen when IT capabilities indirectly enhance firm performance through firms' market-access competency and functionality-related competency (Ravichandran and Lertwongsatien 2005). At the process level of analysis, IT leveraging competence indirectly influences competitive advantage in new product development through functional competencies and dynamic capabilities (Pavlou and El Sawy 2006).

From a moderation perspective, resources can have one of three possible effects on one another: compensatory, enhancing, or suppressing/destroying (Black and Boal 1994). A compensatory relationship exists when a change in the level of one resource is offset by a change in the level of another resource. An enhancing relationship exists when one resource magnifies the impact of another resource. A suppressing relationship exists when the presence of one resource diminishes the impact of another. While an IT resource may have a direct positive effect on customer agility, the net effect of that resource depends on the type and strength of its interactions with complementary resources. For example, IT resources interact with complementary business resources, such as process redesign and supplier relationships, and complementary human resources, such as flexibility or IT/strategy integration, to create superior firm performance (Powell and Dent-Micallef 1997). Similarly, integrated IS capability complements interfunctional coordination mechanisms to increase manufacturing performance (Bharadwaj et al. 2007).

Table 2.7 provides numerous empirical studies which examine the synergistic creation of IT-based value. We follow this line of research by investigating how the synergy derived from the interaction of IT capabilities and organizational factors creates IT-based value – in this case, customer agility. Specifically, we conceptualize and test enhancing relationships between IT resources and complementary resources as they affect a firm's ability to sense and respond quickly to customer-based opportunities for innovation and competitive action. In the next section we extend this line of thinking in our review of the digital options perspective.

Table 2.7. Empirical Studies that Investigate the Synergistic Creation of IT-based Value

Source	IT Capabilities Assessed	Effect Type	Major Findings
Powell and Dent-Micallef (1997)	IT competence	Interactive	The firm's IT competence combined with complementary business and human resources creates superior firm performance.
Bharadwaj (2000)	Conceptualized infrastructure, human IT, and intangibles, but none were measured	Direct	Firms rated as having superior IT capabilities were found to have better financial performance with respect to a control group.
Kearns and Lederer (2003)	Strategic IT alignment and its process and content components	Interactive	Alignment between the IT plan and the business plan creates IT-based value for the firm.
Barua et al. (2004)	Customer-side digitization, online information capability, process alignment, supplier-side digitization, systems integration	Direct and Indirect	Customer-side online information capability indirectly increases firm performance through customer-side digitization; supplier-side online information capability indirectly increases firm performance through supplier-side digitization.
Zhu (2004)	E-commerce capability, IT infrastructure	Interactive	The interactive effect of e-commerce capability and IT infrastructure increases firm performance.
Bhatt and Grover (2005)	IT business experience, IT infrastructure quality, and relationship infrastructure	Direct	Quality of IT business expertise and the relationship infrastructure have a significant effect on competitive advantage.
Malhotra et al. (2005)	Integrative inter-organizational process mechanisms, partner interface directed information systems	Indirect	Integrative inter-organizational process mechanisms and partner interface directed information systems indirectly influence market knowledge creation and operational efficiency through the nature of information exchanged between supply chain partners.

Source	IT Capabilities Assessed	Effect Type	Major Findings
Ravichandran and Lertwongsatien (2005)	IS operations capability, IS planning sophistication, IS support maturity, and systems development capability	Indirect	IT capabilities indirectly enhance firm performance through market-access competency and functionality-related competency.
Ray et al. (2005)	Generic information technologies, IT infrastructure flexibility, IT spending, shared knowledge, technical IT skills	Interactive	Managerial IT knowledge leads to enhanced customer service performance, but flexibility of IT infrastructure, technical IT skills, and IT applications. Further, a complementary interaction between IT applications and managerial IT knowledge enhances performance.
Saeed et al. (2005)	E-commerce competence	Indirect	E-commerce competence indirectly influences firm performance through the generation of customer value through web site functionality.
Pavlou and El Sawy (2006)	IT leveraging competence	Indirect	IT leveraging competence indirectly influences competitive advantage in new product development through functional competencies and dynamic capabilities.
Rai et al. (2006)	IT infrastructure integration for supply chain management, supply chain process integration capability	Indirect	IT infrastructure integration indirectly enhances firm performance through supply chain process integration.
Tanriverdi (2006)	IT relatedness (HR management, infrastructure, strategy making, vendor management)	Interactive	Complementarities among IT infrastructure technologies and IT management processes (i.e., IT relatedness) create IT-based value.
Bharadwaj et al. (2007)	Integrated IS capability	Direct and Interactive	Integrated IS capability complements interfunctional coordination mechanisms to increase manufacturing performance.

Source	IT Capabilities Assessed	Effect Type	Major Findings
Fink and Nuemann (2007)	IT infrastructure, IT personnel	Direct and Indirect	IT personnel capabilities indirectly influence IT-dependent organizational agility through IT infrastructure capability.
Hulland et al. (2007)	IT-enabled cost efficiency, IT skills	Indirect	IT skills capability indirectly influences firm performance through online commitment.
Karimi et al. (2007)	IS resources (infrastructure, knowledge, relationship), ERP capabilities (functional, geographic, organizational)	Interactive	IS resources interact with ERP capabilities to enhance business process outcomes.
Klein et al. (2007)	IT customization, strategic information flows	Direct and Indirect	IT customization and strategic information flows improve relationship-specific performance between cooperative supply chain partners.
Mishra et al. (2007)	Procurement-process digitization, suppliers' sales-process digitization	Indirect	Procurement-process digitization and suppliers' sales-process digitization are both significantly related to Internet-based procurement application usage. The indirect relationship of these two IT capabilities to procurement-process performance was not tested.
Saraf et al. (2007)	IS flexibility, IS integration	Indirect	IS integration indirectly influences firm performance through both knowledge sharing and process coupling capabilities. Furthermore, IS flexibility indirectly creates value by enabling greater IS integration within firms.
Jeffers et al. (2008)	Business-IT knowledge	Interactive	Business-IT knowledge strengthens the relationship between business work practices and customer service process performance.
Dong et al. (2009)	Backend integration, managerial IT skills, partner support	Direct	Backend integration, managerial IT skills, and partner support are significantly related to supply chain process performance.

2.2.4.2 Digital Options

IS scholars have drawn upon the RBV, dynamic capabilities framework, IT capability literature and real options thinking to conceptualize IT as a digital options generator that facilitates agility (Sambamurthy et al. 2003). Digital options refers to a set of IT-enabled capabilities in the form of digitized work processes and knowledge systems. The firm's digital options are built on its organizational base of IT resources and capabilities. Examples of digital "options-like" capabilities include customer-side digitization (Barua et al. 2004), supply chain process integration (Rai et al. 2006), and procurement-process digitization (Mishra et al. 2007). These digital options can extend the reach and richness of firm knowledge and processes (Evans and Wurster 2000; Keen 1991), thereby contributing to organizational agility. Figure 2.6 provides a basic model describing the relationships between IT competence, digital options and agility.

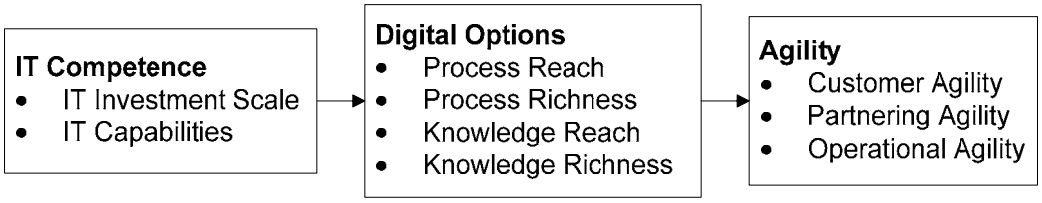


Figure 2.6. Relationships Between IT Competence, Digital Options and Agility (adapted from Sambamurthy et al. 2003)

Real options theory describes how firms can leverage IT investments to sense and respond to market opportunities. Options are rights to future investment choices without a current obligation for full investment (Amram and Kulatilaka 1999). Just as financial call options confer the right, but not the obligation, to obtain benefits from future ownership of traded

securities, an IT investment is an initial expenditure on a technology that creates the right, but not the obligation, to obtain the benefits associated with further development and deployment of the technology (McGrath 1997). For instance, early investments in IT platforms may open up future growth opportunities (Fichman 2004; Taudes 1998). Those firms that defer investment in IT may not have quite the same claim to future benefits because of time-compression diseconomies (Dierickx and Cool 1989).

Our review of the RBV-informed IS literature showed us that firm value is created when IT capabilities and resources interact with complimentary organizational capabilities and resources. The same logic holds for digital options. Although IT investments are necessary to create digital options, IT alone is insufficient to create lasting firm value (e.g., sustained competitive advantage, cf. Mata et al. 1995). Instead, IT creates options which enhance the impact of other capabilities (Sambamurthy et al. 2003). Specifically, information technologies can strengthen organizational processes and knowledge systems (Alavi and Leidner 2001; Davenport 1993; Melville et al. 2004; Overby 2008). The following sections describe how IT can be combined with complementary business processes and knowledge systems to create powerful digital capabilities in the form of digitized knowledge capital and digitized process capital (two subsets of digital options).

Digitized knowledge capital captures the IT-enabled knowledge repository and the systems of interaction among organizational members to generate knowledge sharing of expertise and perspectives (Alavi and Leidner 2001; Grover and Davenport 2001). Knowledge repositories can enable a variety of knowledge reuse mechanisms based on the knowledge reuser and the purpose of knowledge reuse (Markus 2001). IT can also facilitate a knowledge

infrastructure in which organizational members acquire, convert, apply, and protect organizational knowledge (Gold et al. 2001).

Digitized process capital refers to the IT-enabled organizational work processes for automating, informating and integrating activities such as customer capture, order fulfillment, supply chain, product innovation, and manufacturing flow (Davenport 1993; Garvin 1998). For example, customer-side digitization captures the extent to which a firm accomplishes day-to-day business activities electronically including transactions and information exchange facing customers (Barua et al. 2004). A related digital capability is supply chain process integration, which is defined as the degree to which a firm has integrated its physical, financial and information flows with its supply chain partners (Rai et al. 2006). Table 2.8 describes and illustrates digital knowledge capability and digital process capability.

Table 2.8. Types of Digital Capabilities

Digital Capability Type	Definition	Salient Information Technologies	Illustration
Digital knowledge capability	The extent to which IT-enabled knowledge repositories and the systems of interaction among individuals and groups generate knowledge sharing of expertise and perspectives	Intranets, databases, knowledge repositories, wikis, collaborative tools for knowledge sharing	Interpretation systems for interorganizational information refer to IT-based systems that a firm uses to manipulate and interpret information received from its supply chain partners, thereby enhancing knowledge assimilation and transformation (Malhotra et al. 2005)
Digital process capability	The extent to which IT-enabled organizational work processes automate, inform and integrate activities such as customer capture, order fulfillment, supply chain, product innovation, and manufacturing flow	Enterprise resource planning, supply chain management, customer relationship management, procurement applications, tracking technologies	Procurement-process digitization refers to the extent to which an IT infrastructure and applications support efficient procurement in firms, thereby enhancing Internet use in both search and order initiation and completion stages (Mishra et al. 2007)

Coupled with our review of the RBV-informed IS research, this review of the digital capability literature shows us that knowledge and process-based digital capabilities should facilitate the firm's customer agility. In particular, building on the dynamic capabilities literature, knowledge-based digital capabilities will enhance customer sensing capability, and process-based digital capabilities will facilitate customer responding capability. These digital capabilities arise from the interaction between IT capabilities and complimentary organizational factors. Figure 2.7 depicts these interactive effects on customer agility.

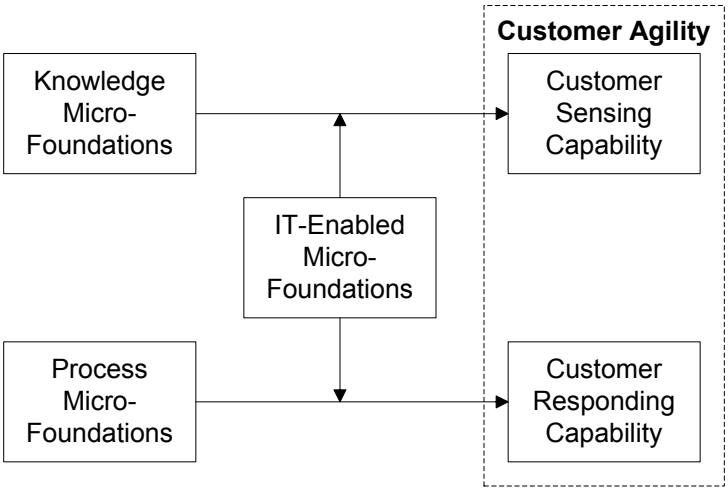


Figure 2.7. Interactive Effects of IT and Organizational Factors on Customer Agility

2.2.5 Summary

In this section we reviewed four streams of literature: dynamic capabilities, capability alignment, competitive dynamics, and IT business value. In doing so we gained a better understanding of customer agility's role in contemporary firms.

The dynamic capabilities literature provided a deeper understanding of customer agility, in particular its sensing and responding components, as well as its antecedents. Dynamic

capabilities are the sets of routines and processes that firms execute to purposefully create, extend or modify their resource base. We conceptualized customer agility as a dynamic capability; specifically, as the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. Customer agility consists of two components: customer sensing capability and customer responding capability. The sensing component will be enabled by "knowledge-based" resources and capabilities, and the responding component will be facilitated by "process-based" resources and capabilities.

We also conceptualized three perspectives of agility alignment, i.e., the fit between customer sensing capability and customer responding capability. One perspective is the moderation view, where we proposed that customer sensing capability moderates the relationship between customer responding capability and competitive activity. The second perspective is matching, which views the fit between customer sensing capability and customer responding capability in terms of high and low combinations, e.g., high customer sensing and high customer responding, high customer sensing and low customer responding. Finally, the mediation perspective views customer responding capability as a significant intervening mechanism between customer sensing capability and competitive activity.

We drew upon the competitive dynamics literature for our ultimate outcome of interest, competitive activity. Competitive actions mediate the relationship between firms' capabilities and financial performance. Hence, firms with more competitive activity will have superior performance over time in relation to rivals with less activity. Organizations that are aware, motivated and able to execute actions are more likely to do so. Within the competitive dynamics framework, customer sensing capability is related to the awareness component, and

customer responding capability is related to the ability component. Thus, competitive activity measures how well a firm senses and responds to customer-based opportunities for innovation and competitive action. Building on these arguments, we integrate competitive activity in our study.

Working in the resource-based view of the firm, IS researchers have conceptualized and empirically tested the direct, indirect and interactive effects of various IT capabilities on the creation of IT-based value. A principal finding is that IT capabilities and resources create value when they operate in a synergistic manner with other organizational capabilities and resources. We aim to build on this well-developed research stream by investigating how the synergy derived from the interaction of IT and organizational capabilities facilitates customer agility, one of many IT-based value outcomes. In particular, IT plays a key role in enhancing customer agility by providing knowledge and process-based digital options (i.e., IT-enabled capabilities). This research in particular builds on the "synergistic" IT capability research noted in the resource-based view section. By extending the reach and richness of the firm's knowledge base and business processes, IT becomes a powerful enabler of customer agility in hypercompetitive environments.

The next section reviews the organizational product innovation literature to formulate a context to study how firms exhibit customer agility.

2.3 Organizational Product Innovation

Innovation is the creation of any product, service, or process which is new to the focal unit (Van de Ven et al. 1999). At the most basic level, there are two types of innovation: product

innovation, or changes in the product a firm makes or the service it provides; and process innovation, a change in the way a product is made or a service is provided (Tushman and Nadler 1986). Since customers are more likely to be familiar with a firm's products than its processes, this study focuses on organizational product innovation. Further, although a firm may exhibit customer agility in a number of areas (e.g., services, quality improvement, market segmentation), this study focuses on customer agility in the context of organizational product innovation.

This section has three components. First, we discuss the difference between radical and incremental innovation and how this distinction is relevant to customer agility. We also examine how organizations are shifting to models of open innovation that involve multiple knowledge sources and innovation partners. Using our discussion of open innovation as a springboard, we investigate the role of the customer and IT in organizational product innovation processes. In doing so we gain a better understanding of how a firm can be agile with respect to its customer-based practices.

2.3.1 Radical vs. Incremental Innovation

The radical versus incremental distinction has long been a central one in the innovation field. Radicalness can be defined in terms of the process of innovation or the outcome of innovation. In terms of the process of innovation, radical innovations "produce fundamental changes in the activities of the organization and represent clear departures from existing practice" (Damanpour 1988, p. 550). In contrast, incremental innovations are minor improvements in current technology. The key difference between radical and incremental is the degree of novel technological process content, or new knowledge embedded in the innovation

(Dewar and Dutton 1986). With respect to outcomes, an innovation is radical when it reduces the cost of production so far that it makes the methods employed by incumbent firms obsolete (Henderson 1993). Such radical innovations frequently represent technological breakthroughs that often have the power to enhance or destroy the competence of firms in an industry (Tushman and Anderson 1986). Since this study focuses on the role of customer agility in organizational product innovation, we examine outcome-oriented approaches to radicalness of innovation.

Firms are more likely to respond to customer-based opportunities for innovation and competitive action by making incremental product improvements. Although customer innovations may be rated important by firms, they are usually low on novelty (Jeppesen and Frederiksen 2006; Morrison et al. 2000). Since customers are most familiar with the firm's existing products and services, they are more likely to extend those products or services rather than breaking with the fundamental concepts of the product (Danneels 2002; 2003). However, firms that cater to their current customers may get stuck in developing incremental new products and miss potential waves of disruptive technologies (Christensen and Bower 1996). Slater and Narver (1998) warned that being customer-led is but a short-term strategy. Moreover, being "customer-compelled" leads to excessive attention on current markets and inadequate attention on emerging markets (Day 1999).

Firms may be able to overcome this "tyranny of the served market" (Hamel and Prahalad 1994) in two ways. First, firms "can serve current customers and remain vigilant for unserved emerging markets" (Day 1999, p. 15). In fact, Chandy and Tellis (1998) found that firms focusing on future customers, rather than on current customers, had a greater degree of radical

product innovation. Second, firms need to stay attuned to both the expressed and latent needs of their customers (Slater and Narver 1998). Marketing scholars and practitioners have developed an extensive toolkit for investigating deep into customers' needs (Aaker et al. 2000). Hence, a firm agile in its customer practices may certainly tend to exhibit more incremental than radical innovation, yet it will also keep an eye toward future market opportunities.

2.3.2 Open vs. Closed Innovation

The traditional model of organizational product innovation is usually conducted within and by a single firm. Within this closed system, firms invest heavily in internal R&D activities which lead to internally developed products that are then distributed by the firm (Van de Ven et al. 1999). The literature suggests that firms are more likely to innovate when they face uncertain environments (Brown and Eisenhardt 1997), enjoy slack resources (Van de Ven et al. 1989), are managed by entrepreneurial managers (Brown and Eisenhardt 1998), have large social networks (Smith et al. 2005), and can readily absorb knowledge from the external environment (Cohen and Levinthal 1990).

The closed innovation paradigm has led to many important achievements and commercial successes (Ettlie 2006). However, rapid changes in globalization, competitive rivalry, customer demands, and technological advancements create an environment in which firms must look beyond their walls for sources of innovation (D'Aveni 1994; Wiggins and Ruefli 2005). Firms operating in these high-velocity conditions are moving toward distributed and open models of innovation (Dodgson et al. 2006; Sawhney and Prandelli 2000; Von Hippel and Von Krogh 2006). An open innovation approach treats R&D as an open system where firms use external ideas as well as internal ideas, and internal and external paths to market, as they look

to advance their products (Chesbrough 2003; Von Hippel 2005). Table 2.9 compares principles of closed and open innovation.

Table 2.9. Principles of Closed and Open Innovation (adapted from Chesbrough 2003)

Closed Innovation Principles	Open Innovation Principles
To profit from R&D, firms must discover, develop and ship it themselves.	External R&D can create significant value; internal R&D is needed to absorb some of that value.
Firms that discover innovations first will get them to market first.	Firms do not have to originate the research to profit from it.
Firms that create the most and the best innovations in the industry will enjoy a competitive advantage.	Firms that make the best use of internal and external innovations will enjoy a competitive advantage.
Firms should control their intellectual property so that competitors do not profit from it.	Firms should profit from others' use of their intellectual property, and firms should purchase others' intellectual property when it advances their business pursuits.

Firms are taking the open approach to innovation one step further by developing webs of multiple partners in network-centric innovation, which refers to "an externally focused approach to innovation that relies on harnessing the resources and capabilities of external networks and communities to amplify or enhance innovation reach, innovation speed, and the quality of innovation outcomes" (Nambisan and Sawhney 2008, p. 23). In doing so, many firms have recognized their customers as a valuable source of innovation (Jeppesen and Frederiksen 2006; Prahalad and Ramaswamy 2004; Thomke and von Hippel 2002; Von Hippel 1988). For instance, firms are involving customers in their innovation processes in a range of industries, from software to sports (Von Hippel 2001). Collaborating with customers in product innovation processes is one way in which firms sense and respond to customer-based opportunities for

innovation and competitive action. In short, involving customers in their innovation processes is one way in which firms exercise customer agility.

A firm can sense valuable customer knowledge and input regarding new products, and in turn the firm can respond to this customer-based opportunity by creating and manufacturing new products. Although some product development processes such as design and manufacturing may take place within the firm, what is important to remember is that one or more components of the entire innovation process may involve the customer (Nambisan and Sawhney 2008). Furthermore, as we note in the next section, some key product development processes, such as design and development, may involve a joint effort on the part of customers and firms. In the next section we discuss how customers play various roles in organizational product innovation (hereafter referred to by its more accepted name, new product development, cf. Brown and Eisenhardt 1995).

2.3.3 Customer Roles in New Product Development

New product development (NPD) is the process of bringing a new product to market, including idea generation and idea screening, concept development and testing, business analysis, prototype and market testing, technical implementation, and plans for product commercialization and launch (Brown and Eisenhardt 1995). NPD is a strategic process wherein firms integrate a diverse set of units (e.g., R&D scientists, engineers, customers, and marketers) to jointly develop and launch new products (Clark and Fujimoto 1991). Thus, successful NPD is often the result of extensive planning of a superior product for an attractive market and the execution of that plan by a capable and well-coordinated cross-functional team that operates with the support of senior management (Brown and Eisenhardt 1995). Based on this perspective, we can conceptualize NPD as an input-process-output model. Input refers to idea

generation and idea selection; process includes product design and product testing; and the output refers to market launch and product support. Figure 2.8 exemplifies the basic NPD cycle.

Figure 2.8. New Product Development Life Cycle

Customers can serve one or more roles in the NPD life cycle: as a source of innovation ideas, as a cocreator in the development and design of products and services, and as a user in testing the product or in helping other users learn about the product or service (Kaulio 1998; Lengnick-Hall 1996; Nambisan 2002). Customers' role as resource and cocreator are at the input side of firm activity, and customers' role as user resides at the output side of the system. Furthermore, customer involvement will vary by product development stage. For instance, customers can serve as a resource for new ideas during the input stage. Organizations can leverage customers as cocreators in product design and users in testing products during the NPD process. Finally, customers can serve as users in supporting peer users of the product in the output stage. The next sections detail 1) each of these customer roles, 2) managerial challenges associated with each role and 3) how IT facilitates customer involvement in each of these roles.

2.3.3.1 Customer as Resource

Customers' role as resource is most often associated with supplying information and wealth to firms (Lengnick-Hall 1996). In the NPD context, customers may be viewed as a source of new product ideas. Customers' role in idea generation or product conceptualization is

relatively well established in the marketing literature and NPD literature (e.g., Christensen 1997; Leonard-Barton 1995; Von Hippel 1988).

Despite the potential payoff from involving customers as an information resource during the NPD process, customers have played a largely passive role even in those contexts where they are a promising resource. Customers rarely offer new product ideas without being encouraged by firms (Brown and Eisenhardt 1995). Although firms often employ a range of structured inquiry mechanisms, such as market surveys or focus groups, to import customer knowledge, the use of these mechanisms severely limits the richness and frequency of customer contributions. Also, logistical and economic conditions force firms to involve only a minority of customers who are often unrepresentative of the diverse customer population (Wayland and Cole 1997). In certain industries like software development, lead customers or lead users have been portrayed as taking more active roles as they, in the process of finding "solutions" to internal problems, generate new product ideas (Von Hippel 1988).

Firms face three major challenges in using customers as a source of new product ideas (Nambisan 2002). The first challenge relates to selecting and establishing ties with customer innovators. Firms often find it difficult to locate competent customer innovators in a cost-effective manner. Another challenge relates to creating appropriate incentives to encourage customer willingness to contribute new product ideas. Finally, a third challenge relates to capturing customer knowledge. It is much more effective to understand customers and their requirements in their own natural settings than in artificial settings (Leonard-Barton 1995). However, the cost and the availability of suitable technologies have so far limited such proactive and "natural" knowledge capture.

Advances in information and communication technologies have brought about a variety of tools by which firms can leverage their customers as an information resource (Nambisan 2002; Sawhney et al. 2005). For instance, online questionnaires allow firms to reach broad audiences to gain a better understanding of customer preferences regarding current and potentially new products and services. Firms can also use online suggestion boxes where customers express their own ideas. For example, Starbucks hosts a web site in which visitors can contribute new ideas for both products and services (www.mystarbucksidea.com). New product idea generation may also originate from online communities of customers, which consist of users sharing similar interests who are often willing to exchange ideas, opinions, and experiences. For example, creative and skilled customers working in an online environment share knowledge and innovative ideas regarding basketball shoes (Fuller et al. 2007). Hence, IT-enabled tools such as online questionnaires and online communities greatly reduce the logistical and economic burdens of interacting directly with customers.

2.3.3.2 Customer as Cocreator

Customers may also serve as cocreators of new products, in which their participation ranges from product design activities to product development activities (Prandelli et al. 2006). As cocreators of products, customers can contribute to a variety of product design and development activities, including the validation of product architectural choices, the design and prioritization of product features, and the specification of product interface requirements.

The role of customer as cocreator is perhaps more evident in industrial products than in consumer products (Garvin 1988). For instance, enterprise software developers like Microsoft, Oracle and SAP often have representatives from customer organizations as members of their

product development teams (Hoch et al. 1999). By providing toolkits for user innovation, some firms have further broken down the product design process by transferring need-related aspects of product and service development to users (Von Hippel and Katz 2002). In the consumer sector, customers have played the role of product cocreator by participating in concept testing (Page and Rosenbaum 1992), consumer idealized design (Ciccantelli and Magidson 1993) and component selection (Park et al. 2000).

Involving customers as cocreators can create significant management challenges. First, customer involvement in product design and development is likely to increase the level of project uncertainty, and new mechanisms and project management approaches may be needed to monitor and control for development quality and efficiency (MacKormack et al. 2001). Further, customers may abandon their role as cocreators, thereby severely disrupting the development process. Likewise, customers may join or be integrated into the development process at disparate stages. Second, customers may need to possess higher levels of product/technology knowledge; hence, firms may need to invest in enhancing their technology awareness. Finally, compared to the role of customer as resource, customer-firm interactions tend to be much more intense and frequent during cocreation (Sawhney and Prandelli 2000); also, mechanisms to support such interactions are costly and technology intensive.

In a vein similar to the customer's role as resource, IT-enabled tools allow customers to cocreate products and services provided by the firm (Bolton and Saxena-Iyer 2009; Thomke and von Hippel 2002). For example, Nike's web site allows customers to either add attributes to a basic shoe model or eliminate undesirable ones from the entire configuration (Park et al. 2000). The concept of toolkits for user innovation has been proposed to speed up and enhance product

development efforts (Von Hippel and Katz 2002). These toolkits are coordinated sets of user-friendly tools that allow users to develop their own innovations and also eliminate the problems of sharing customer knowledge, often considered sticky due to its context-specific nature (Von Hippel 1998). Within the toolkit's design space, the user is free to innovate, develop customized products by trial and error, and even propose new patents. Web-based toolkits have been successfully developed in the computer circuits, plastics and consumer goods industries (Thomke and von Hippel 2002).

2.3.3.3 Customer as User

As primary recipients and users of goods and services, customers traditionally contribute to product testing and product support. Customers can play a highly productive role in product and prototype testing (e.g., Dolan and Mathews 1993; Nielsen 1993). For example, in the software industry many firms have used their customers in beta product testing, thereby enabling those firms to reduce their investments in internal product testing units (Cusumano and Yoffie 1998). Customer involvement in product testing enables firms to detect product flaws early in the development cycle and to minimize costly redesign, rework and, in extreme cases, recall. Further, by involving a diverse set of customers in product testing, firms can gain a better understanding of how the product would fare in a variety of user contexts.

As product users, customers are uniquely qualified to provide product support for other users. Customers often acquire significant knowledge of or expertise on various aspects of product usage, which then becomes the basis for providing product support for peer users. The homophily or degree to which pairs of individuals are alike in terms of certain attributes between peer customers contributes to their effectiveness in understanding and appreciating

the concerns of product users and their particular usage problems – a critical success factor in product support (Brown and Reingen 1987). Additionally, over a period of time, expert users may discover new ways to use the product as well as shortcuts and other methods to enhance the overall value of the product.

Two main challenges can be identified regarding the customer as user role. First, in both cases, customer contributions can be limited by the high cost of providing facilities or mechanisms to structure and channel those customers' inputs. For instance, customers' role as product support specialists calls for forums that can support rich interactions among customers. The second challenge relates to insuring the involvement of a diverse set of customers. This is particularly true in the case of product testing, where firms are often forced to make tradeoffs between customer diversity and testing duration while devising their product testing strategy (Dolan and Mathews 1993).

Powerful web-based tools enable customers to test products and support other customers with product-related problems. Simulation technologies like Second Life (www.secondlife.com) can make the product testing stage more efficient (Hemp 2006; Thomke 1998). Also, virtual reality and animation tools enable low-cost virtual prototypes. Specifically, a virtual representation of the product, combined with streaming video and interactive sensory capabilities, allows visual, auditory and tactile information to be effectively distributed to users (Dahan and Srinivasan 2000). BMW's web site allows customers to view detailed descriptions of prototypes combined with virtual tours around and inside their products. With respect to product support, virtual communities provide a forum in which customers can tap into a vast repository of product-specific knowledge held by other customers (Nambisan 2002). Customers

can use web-based discussion boards to post and reply to product support questions (Wiertz and Ruyter 2007). Table 2.10 summarizes our discussion of customer roles across stages of the NPD process.

Table 2.10. Customer Roles in the NPD Process

Customer Role	NPD Stage	Example of Customer Involvement	Managerial Challenges
Resource	Idea Generation	• Starbucks uses a web site to solicit ideas from customers for future products and services (www.mystarbucksidea.com). • CNN allows customers to post news stories, comments and photos on its iReport web site (www.ireport.com).	• Selection of customer innovator • Creation of appropriate customer incentives • Infrastructure for capturing customer knowledge
Cocreator	Product Design	• Proctor & Gamble collaborates with customers on new product development through a web-based portal (www.pgconnectdevelop.com). • National Semiconductor offers a toolkit called Webench (webench.national.com), an online environment in which customers can design and test new circuits.	• Managing project uncertainty • Enhancing customers' knowledge • Tighter coupling between firm and customer
User	Product Testing Product Support	• Microsoft releases beta products to advanced customers for testing and feedback (msdn.microsoft.com). • Electronic Arts provides an interactive forum (forums.easports.com) in which customers support each other with advice and solutions for video games.	• Infrastructure to support customer interactions • Ensuring customer diversity

2.3.4 Summary

Our review of the organizational product innovation literature provides several interesting insights into how firms can be "customer agile" in a new product development context. Since customers are most familiar with the firm's existing products and services, they are more likely to extend those products or services rather than contribute radically new ideas. As a result, customer agile firms are more likely to exhibit exploitative, incremental innovation. However, customer agile firms may also break away from the rut of incremental innovation by 1) soliciting radical ideas from customers, 2) paying attention to both current and potential future customers, and 3) discovering customers' expressed and latent needs. In doing so firms may be better equipped to perceive potential waves of disruptive innovations in their industry.

We also noted that hypercompetitive conditions are forcing firms to embrace open models of innovation that leverage multiple partners and sources of R&D. One innovation partner is the customer, who can serve multiple roles in new product development processes: as a resource of information, as a cocreator of products and services, and as a user in product testing and product support. While there are managerial challenges associated with integrating customers in each of these roles, managers can address these challenges by taking advantage of flexible, powerful IT capabilities and resources.

2.4 Chapter Summary

This chapter reviewed literature pertaining to concepts related to customer agility, dynamic capabilities, capability alignment, competitive dynamics, IT business value, and organizational product innovation. Table 2.11 details key points and takeaways from the contributing literature.

Table 2.11. Key Points and Takeaways from the Contributing Literature

Literature Stream	Key Points	Takeaways	Contributing Literature
Related Concepts	• Absorptive capacity is the firm's ability to identify, assimilate, transform, and apply external knowledge. • Exploration refers to learning gained experimentation, variation and quests for knowledge; exploitation refers to learning gained via local search, refinement and the use of existing knowledge. • Market orientation refers to the extent to which organizations generate, disseminate and respond to market intelligence pertaining to current and future customer needs.	• Customer agility refers to the firm's ability to manage changes in customer preferences and needs, not necessarily customer knowledge. • Exploration and exploitation are logically incompatible; sensing and responding are not necessarily incompatible. Also, a response must follow some type of sensing activity; on the other hand, exploitation does not necessarily follow exploration. • While market oriented firms are likely to be "customer agile," firms may be agile without necessarily disseminating information across subunits.	(Baum et al. 2000; Cohen and Levinthal 1990; Gupta et al. 2006; Homburg et al. 2007; Hult et al. 2005; Jayachandran et al. 2004; Kohli and Jaworski 1990; Lane et al. 2006; Levinthal and March 1993; March 1991; 1996; Todorova and Durisin 2007; Zahra and George 2002)

Literature Stream	Key Points	Takeaways	Contributing Literature
Customer Agility and the Role of the Firm	• Dynamic capabilities constitute the processes by which firms sense and seize opportunities through enhancing and reconfiguring the firm's intangible and tangible assets in pursuit of improved organizational effectiveness. • Sensing capability can be increased through knowledge-based systems; responding capability through well-coordinated processes. • To achieve maximum benefit, organizational capabilities should be internally and externally aligned. • A firm's competitive activity affects its performance relative to competitors . • IT resources can form digital options (a set of IT-enabled capabilities in the form of digitized work processes and knowledge systems).	• As a dynamic capability, customer agility refers to the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. • Knowledge generation and transfer enhance customer sensing capability; process capabilities facilitate customer responding capability. • A firm's sensing capability should be aligned with its responding capability, either with a moderation, mediation or matching perspective. • Customer agility will be manifested in a firm's competitive activity. • By extending reach and richness of both knowledge and process capabilities, IT can facilitate customer agility.	(Alavi and Leidner 2001; Barney 1986; 1991; Bharadwaj 2000; Bharadwaj et al. 2007; Brown and Eisenhardt 1997; Chen 1996; D'Aveni 1994; Eisenhardt and Martin 2000; Ferrier 2001; Ferrier et al. 1999; Galbraith 1973; Nambisan 2002; Sambamurthy et al. 2003; Schumpeter 1934; Teece 2007; Teece et al. 1997; Tippins and Sohi 2003; Wernerfelt 1984; Young et al. 1996; Zaheer and Zaheer 1997; Zollo and Winter 2002)

Literature Stream	Key Points	Takeaways	Contributing Literature
Organizational Product Innovation	• Radical innovations can enhance or destroy firm competencies; incremental innovations leverage firm's existing competencies. • Firms are moving from closed innovation models to open innovation models involving multiple partners, one of which is their customer base. • IT can greatly enhance open innovation processes.	• While exercising customer agility is more likely to lead to incremental innovation, firms can fend off exploitation by seeking out potential future customers and customers' latent needs. • IT can facilitate three customer roles in new product development: resource, cocreator and user.	(Chesbrough 2003; Danneels 2003; Day 1999; Henderson 1993; Lengnick-Hall 1996; Nambisan 2002; Prandelli et al. 2006; Sawhney and Prandelli 2000; Slater and Narver 1998; Tushman and Anderson 1986)

Our review finds that customer agility is characterized in several ways. Customer agility is an organizational capability that consists of two distinct components: sense and respond. Also, the term agility implies quickness. We find that customer agility overlaps with a number of well-established concepts and constructs, including absorptive capacity, exploration/exploitation and market orientation. While these overlaps provide some insight into the nature of customer agility, we find that customer agility emerges as a distinct construct. In particular, customer agility is defined as the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. Demarcating customer agility's distinct boundaries also allowed us to draw upon broader theoretical perspectives to further our understanding of customer agility.

We drew upon the dynamic capabilities perspective to develop an informed understanding of customer agility's role and importance to modern organizations. We noted that customer agility is a dynamic capability with two distinct components – sensing and responding – that are facilitated by knowledge-based structures and process-based mechanisms, respectively. In particular, a firm's ability to sense customer-based opportunities for innovation and competitive action depends upon its ability to collect, assimilate, disseminate, and apply relevant knowledge and information from customers. Moreover, a firm's ability to respond quickly to such opportunities depends upon the efficiency and effectiveness of its business processes, resources and capabilities.

We also noted that a firm should strive to achieve a good fit between its customer sensing capability and customer responding capability. We reviewed moderation, matching and mediation perspectives of agility alignment. We also reviewed the competitive dynamics

literature to reveal an appropriate consequence of customer agility – competitive activity. Finally, we also investigated how the combination of IT capabilities and complementary organizational capabilities can create value for firms in terms of customer agility and competitive activity.

Our review of the organizational product innovation literature showed us one of many ways in which firms can practice customer agility. Firms are moving toward open innovation models that involve multiple partners, one of which is their customer base. Furthermore, while customers are more likely to engage in incremental innovation practices, firms can stave off the rut of incrementalism by tapping into customers' latent needs. We also uncovered three roles customers can play across the new product development life cycle: as an information resource, as a cocreator of products and services, and as a user in product testing and product support. Moreover, we noted numerous ways in which IT can facilitate each of these customer roles.

In the next chapter we present our research model, provide definitions of our constructs, and present our research hypotheses.

CHAPTER THREE: RESEARCH MODEL

3.0 Introduction

In this chapter we present the research model, elaborate the constructs, and propose research hypotheses. Figure 3.1 depicts a high-level research framework. As noted in the previous chapter, theory suggests that organizational micro-foundations enable firms to sense and respond to customer-based opportunities for innovation and competitive action, which subsequently impacts competitive activity (Haeckel 1999; Sambamurthy et al. 2003; Teece 2007). Specifically, a firm's ability to sense market opportunities rests on its ability to create, assimilate and synthesize relevant information and knowledge from a variety of sources. Furthermore, a firm's ability to respond quickly to opportunities depends upon the effectiveness of its processes and operations.

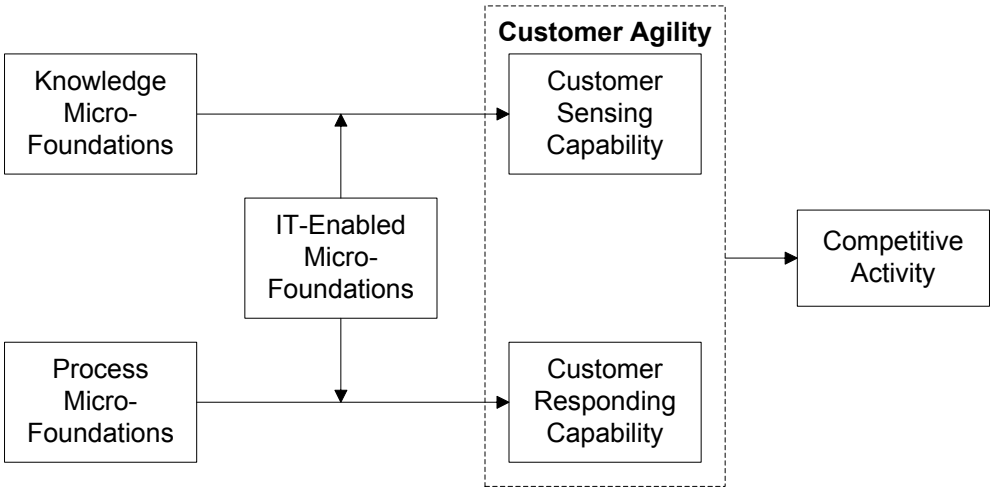


Figure 3.1. Basic Research Framework

We also noted that a well-developed stream of research finds that IT-enabled micro-foundations create value when they operate in a synergistic manner with complementary organizational factors. The effects of IT capabilities on the creation of IT-based value can be direct, indirect or interactive. We build on this body of work by investigating how the synergy derived from the interaction of IT and organizational micro-foundations facilitates customer agility, one of many IT-based value outcomes. In particular, we propose that IT-enabled micro-foundations moderate the relationship between knowledge-based micro-foundations and customer sensing capability. For instance, an Internet-based customer community can generate a wealth of information which firms can use to sense opportunities for improvement and innovation; moreover, IT-based analytical tools can help firms make sense of these voluminous levels of incoming data. Further, IT-enabled micro-foundations moderate the relationship between process-based micro-foundations and customer responding capability. For example, the synergy created by well-coordinated organizational functions operating with an integrated set of information systems will substantially increase the firm's ability to respond to opportunities. On the right-hand side, customer agility will have a positive effect on the firm's competitive activity. The next section draws upon this framework to formulate a specific, testable research model used in this study.

3.1 Research Model

The formal research model is presented in Figure 3.2. The model proposes that web-based resource infrastructure, cocreation infrastructure and user infrastructure are main antecedents to customer sensing capability. Furthermore, these relationships will be moderated by analytical ability. Antecedents to customer responding capability include interfunctional

coordination and channel coordination. Internal IS integration is conceptualized as a moderator of the relationship between interfunctional coordination and customer responding capability, and external IS integration is proposed to be a moderator of the relationship between channel coordination and customer responding capability. The second half of the research model proposes that customer agility affects competitive activity. However, the full effect of customer agility on competitive activity will take place when a firm's customer sensing capability and customer responding capability are in alignment. Finally, we include salient control variables for competitive activity. In the next section we further discuss the constructs in the research model.

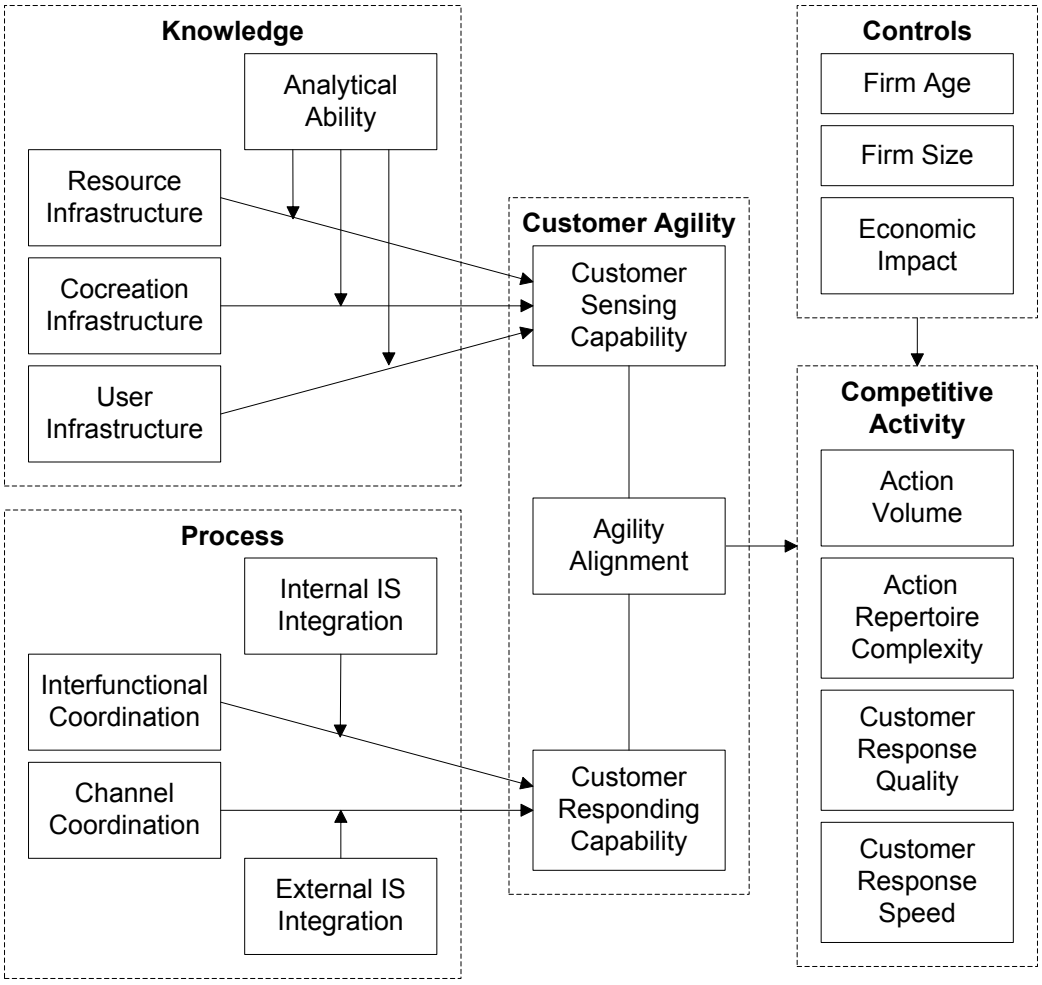


Figure 3.2. Research Model

3.1.1 Customer Agility

Customer agility is defined as the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. Customer-based opportunities originate from (1) individual customers, (2) discussions among customers or (3) interactions between customers and a representative of the focal firm. For example, highly motivated and innovative individuals have contributed to radical advances in medical imaging technology (Lettl et al. 2006). Firms have also developed product innovations originating from

customer interactions in virtual communities (Jeppesen and Frederiksen 2006). We divide customer agility into two components: customer sensing capability and customer responding capability.

3.1.1.1 Customer Sensing Capability

Customer sensing capability is the degree to which a firm is able to sense customer-based opportunities for innovation and competitive action. As noted in Chapter 2, sensing new opportunities is very much a scanning, creation, learning, and interpretive activity (Teece 2007). To identify and shape opportunities, firms must constantly search and explore across technologies and markets, both local and distant (Benner and Tushman 2003; March 1991; Nelson and Winter 1982). Firms proficient at information acquisition, distribution, interpretation, and application can sense events and trends in their markets ahead of their competitors (Cohen and Levinthal 1994). They can also anticipate more accurately the responses to actions designed to keep or attract customers (Day 1994).

The sensing process is fueled by data which, in turn, creates information within the firm. As noted in Chapter 2, much of this information usually centers on customers' expressed needs, which refer to the needs of a customer of which the customer is aware and, therefore, can express. An expressed need is "thirst" for which one expressed solution may be "water." On the other hand, latent needs are defined as needs of which the customer is unaware. Latent needs are no less "real" than expressed needs, but they are not in the consciousness of the customer. For instance, at the outset of the development of Global Positioning Systems (GPS), the need for the benefits of a personal in-vehicle GPS was a latent need.

Our review of the literature found that customers are more likely to extend existing products and services than create or offer ideas for radical new products or services (Danneels 2003). As a result, firms that cater to current customers' expressed needs may fall into a vicious cycle of incremental product development, possibly missing radical and potentially disruptive innovations (Christensen and Bower 1996). A strong customer sensing capability fends off incrementalism by recognizing customers' expressed needs and latent needs (Narver et al. 2004). Discovering latent needs requires translating information into insight (Ferguson et al. 2005). Thus, firms should search for patterns in data to gain insight into potential opportunities. To put it succinctly, management must "find methods and procedures to peer through the fog of uncertainty and gain insight" (Teece 2007, p. 1326). By moving beyond typical data and information reports, insightful managers are more likely to sense a greater number and variety of market opportunities (Haeckel 1999).

3.1.1.2 Customer Responding Capability

Customer responding capability is the extent to which a firm is able to respond quickly to customer-based opportunities for innovation and competitive action. Once an opportunity for innovation or competitive action is sensed, it must be addressed by mobilizing the firm's existing processes or services. In particular, a firm's responding capability may be viewed as the physical ability to act (Dove 2001). Responding to opportunities involves maintaining and developing technological resources and complementary assets and then investing heavily in the particular technologies and designs most likely to achieve marketplace acceptance (Teece 2007).

There are a variety of responses a firm can make, ranging from (1) a complex move, such as developing a new product line, to (2) a simple move, such as improving an existing

product line, to (3) no move (Ferrier et al. 1999; Young et al. 1996). A complex move encompasses such responses as launching a new product, creating a new distribution channel, or targeting a new customer segment. Examples of simple moves include making a price change, increasing or decreasing production of an existing product, or adjusting product features. Firms may also respond by taking no action, so long as the inactivity is calculated and not merely an artifact of a failure to sense an opportunity (Overby et al. 2006). An agile firm does not necessarily need to be agile for every opportunity.

3.1.1.3 Agility Alignment

As noted in our literature review, although customer agility consists of both customer sensing capability and customer responding capability, it is important that these two capabilities "fit" or are aligned with each other (Overby et al. 2006). Scholars argue that sensing and responding capabilities need to be simultaneously developed and applied in order for firms to reap the benefits of agility (Haeckel 1999; Teece 2007). In Chapter 2 we found three perspectives of "fit" salient to customer agility: moderation, matching and mediation. In this section we briefly reiterate these three views.

According to the moderation perspective, the fit between the predictor and the moderator is the primary determinant of the criterion variable. When applied to customer agility, a firm's competitive activity is manifested through its customer responding capability. Hence, the impact of customer responding capability, the predictor. on competitive activity varies across the different levels of customer sensing capability. The matching perspective is used for concepts in which fit is a theoretically defined match between two related variables.

The basic premise is that the stronger the match between customer sensing capability and customer responding capability, the greater the effect of customer agility on a criterion variable.

Finally, the mediation perspective specifies the existence of a significant intervening mechanism between an antecedent variable and the dependent variable of interest. When applied to customer agility, customer responding capability mediates the relationship between customer sensing capability and competitive activity. As will be described in greater detail in the hypothesis section, we focus on these three perspectives to conceptualize the relationship between agility alignment and competitive activity. Details of the analytical issues underpinning agility alignment are presented in Chapter 4.

3.1.2 Knowledge Micro-Foundations

As noted in Chapter 2, the firm's ability to sense market opportunities depends on its ability to create and leverage knowledge (Haeckel 1999; Teece 2007). Creating this knowledge requires the collection of relevant data and information. To collect data and information concerning customer-based opportunities for innovation and competitive action in a new product development environment, firms need to develop and maintain infrastructures that allow customers to perform the three NPD roles reviewed earlier: resource, cocreator and user. Furthermore, the Internet is critical to forming an environment in which customers can meaningfully contribute to a firm's NPD efforts (Nambisan 2002; Prandelli et al. 2006; Sawhney et al. 2005). Thus, for our knowledge micro-foundations we derive the notion of "web-based infrastructure" based on the broader concept of IT infrastructure.

The firm's IT infrastructure facilitates customer involvement as NPD resource, cocreator and user. IT infrastructure refers to an arrangement of shared technical components and IT

services: platforms (hardware and operating systems), networks and telecommunications, data, and software applications (Bharadwaj 2000; Duncan 1995; Weill 1993). Scholars have argued that a well-crafted IT infrastructure may contribute to the organization's ability to sense and respond to environmental change (Haeckel 1999; Weill et al. 2002). Recent empirical evidence supports a relationship between IT infrastructure capabilities and IT-dependent organizational agility (Fink and Neumann 2007).

For this study a web-based infrastructure is particularly important in facilitating customer NPD roles. The firm's web-based infrastructure is considered to be a subset of its overall IT infrastructure. Web-based infrastructure is defined as the number of firm-provided web-based IT tools that support varied customer roles in new product development. As discussed in Chapter 1, by customer we refer to the traditional consumer, e.g., an individual who purchases a personal computer from Dell, a situation also referred to as the consumer-producer relationship or the business-to-consumer relationship. We do not include firm-level customers or suppliers, e.g., IBM purchases mass quantities of office supplies from Office Depot.

The extended reach, enhanced interactivity, increased speed, and greater flexibility provided by web-based tools combine to produce three important benefits for collaborative innovation with customers: (1) the direction of communication, (2) the intensity and richness of the interaction and (3) the size and scope of the audience (Sawhney et al. 2005). The direction of interaction evolves from one-way knowledge import to an interactive dialogue that helps firms to progressively learn about and learn from individual customers and groups of customers. The richness of the interaction increases because web-based infrastructures help firms to tap into social knowledge in addition to individual customer knowledge (Nonaka and Konno 1998).

Finally, a web-based infrastructure allows the firm to reach a greater number of customers than offline tools, thereby exponentially increasing the size and scope of the firm's audience.

Based on our literature review, customers can perform three roles in NPD processes that generate potentially valuable information to a firm: (1) customers can serve as information resources for new products and improvements to existing products; (2) customers can play a role as cocreators of new products, in which their participation ranges from product design activities to product development activities; and (3) customers can also provide information in their role as product users in product testing and product support. In the following sections we describe three types of web-based infrastructures that allow customers to perform NPD roles: resource infrastructure, cocreation infrastructure and user infrastructure.

We also note that web-based tools can generate massive amounts of data which may subsequently overwhelm managers looking for insight and market opportunities. Hence, we conceptualize analytical ability as a key moderator of the relationship between web-based infrastructure (resource, cocreation and user) and customer sensing capability. The basic rationale is that analytical tools can aid managers who are trying to find patterns and make sense of large volumes of customer-related information (Davenport and Harris 2007). We elaborate on these arguments after we define and describe our constructs.

3.1.2.1 Resource Infrastructure

A web-based resource infrastructure consists of a variety of web-based tools that allow customers to serve as information resources concerning new products and services (Nambisan 2002; Sawhney et al. 2005). The use of online questionnaires can reduce uncertainty by identifying customer preferences regarding current and potentially new products and services.

Firms can use online suggestion boxes where customers express their own ideas. On the Ben & Jerry web site visitors can contribute new ideas for both products like pre-packaged ice cream and services like packaging and distribution.

New product ideas may also originate from online virtual communities of customers. These communities consist of users who share similar interests and are often willing to exchange ideas, opinions and experiences. For example, creative and skilled customers working in a virtual environment share knowledge and innovative ideas regarding basketball shoes (Fuller et al. 2007). By encouraging iterative communication, these online groups generate and transfer knowledge shared at a social level that is difficult to acquire using other research tools (Brown and Duguid 1991; Leonard-Barton 1995). Furthermore, because of their competence, the contributions of such groups are particularly valuable (Prandelli et al. 2006). Hence, IT-enabled mechanisms such as online questionnaires and virtual customer communities greatly reduce the logistical and economic burdens of interacting directly with customers.

3.1.2.2 Cocreation Infrastructure

A web-based cocreation infrastructure provides tools that allow customers to cocreate products and services provided by the firm. Customers can apply web-based conjoint analysis tools to select different product features (Prandelli et al. 2006). Conjoint analysis is an exercise in which participants make a series of trade-offs which reveal the relative importance of component attributes. Nike's web site allows customers to either add attributes to a basic shoe model or eliminate undesirable ones from the entire configuration (Park et al. 2000). With web-based technologies, firms can identify as much information as traditional conjoint analysis – key features users prefer, attributes that interact and the ideal combination of these attributes

(Prandelli et al. 2006). However, one key advantage of the Internet is its ability to reach a much larger audience than traditional offline tools. As a result, a firm can collect vast quantities of rich information related to customer-involved cocreation activities.

A cocreation infrastructure also includes toolkits for user innovation, a concept which has been proposed to speed up and enhance product development efforts (Von Hippel and Katz 2002). These toolkits are coordinated sets of user-friendly tools that allow users to develop their own innovations and also eliminate the problems of sharing customer knowledge, often considered sticky due to its context-specific nature (Von Hippel 1998). Within the toolkit's design space, the user is free to innovate, develop customized products by trial and error, and even propose new patents. Web-based toolkits have been successfully developed in the computer circuits, plastics and consumer goods industries (Thomke and von Hippel 2002). For example, customers have engaged in long-lasting, continuous, evolving, and intense innovation activities when playing *The Sims* game (Prugl and Schreier 2006). Such customers employ web-based tools to push design possibilities even further, thereby exhibiting behaviors which would not be possible to capture in artificial settings.

We note that some cocreation tools enable product or service customization, while others do not. National Semiconductor offers a toolkit called Webench (webench.national.com), an online environment in which customers can design and test new circuits. Using Webench tools, customers can design and test new circuits, and can have prototype power supply kits delivered in 48 hours. The Webench tool is an example of customization. On the other hand, many of the major automobile manufacturers provide online environments in which customers can select automobile features based on their preferences. However, customers cannot

purchase customized automobiles from the website, at least not at the time of this writing. It is important to note that regardless of whether or not a specific cocreation tool enables customization, the firm is able to collect data regarding customer preferences through customer use of the cocreation tool. Using technologies such as web-tracking behavior, firms can collect and analyze volumes of customer behavior based on the "clicks" a customer makes as he/she navigates the cocreation process. For our purposes, the customization aspect is only important in that it gives firms that much more information regarding how and what customers actually customize and potentially purchase, i.e., it provides more information that can then be integrated into the firm's knowledge base.

3.1.2.3 User Infrastructure

A web-based user infrastructure consists of web-based tools that allow customers to test products and support other customers with product-related problems. Firms can gather more information regarding potential product defects by deploying product testing web-based simulation technologies to a large and diverse customer base, thereby making the product testing stage more efficient (Hemp 2006; Thomke 1998). Also, virtual reality and animation tools enable low-cost virtual prototypes. Specifically, a virtual representation of the product, combined with streaming video and interactive sensory capabilities, allows visual, auditory and tactile information to be effectively distributed to users (Dahan and Srinivasan 2000). Customers can view detailed descriptions of prototypes combined with virtual tours around and inside the product. By doing so the firm can collect much more information than possible with traditional offline tools. With respect to product support, virtual communities provide a forum in which customers can tap into a vast repository of product-specific knowledge held by other customers (Nambisan 2002). Customers can use web-based discussion boards to post and reply to product

support questions (Nambisan and Baron 2007). Firms can gather and mine this information to get a better sense of product problems or even product enhancements. Table 3.1 details customer role and a subset of IT-enabled tools in different stages of the NPD process. A comprehensive set of web-based infrastructure tools is provided in Chapter 4.

Table 3.1. IT-enabled Tools Which Support Customer Roles in the NPD Process

NPD Stage	Customer Role	Typical IT-enabled Tools
Idea Generation	Resource	Online questionnaire, suggestion box
Product Design	Cocreator	Conjoint analysis, design toolkits
Product Testing	User	Simulation technologies, virtual product test
Product Support	User	Online forum, wiki

3.1.2.4 Analytical Ability

IT competency refers to the extent to which a firm is knowledgeable about and effectively utilizes IT tools to manage information within the firm (Tippins and Sohi 2003). We draw from this research to define analytical ability, which refers to the extent to which IT applications provide analytical tools to support decision-making in the context of customer interactions. Furthermore, our concept of analytical ability is also based on the broader management support systems literature. Management support systems refer to a broad class of systems whose fundamental purpose is the support of managerial actions and decision making, including decision support, executive information, knowledge management, and business intelligence (Clark et al. 2007). Analytical tools are a subset of business intelligence. Business intelligence refers to a set of technologies and processes that use data to understand and analyze business performance (Negash 2004). Components of business intelligence include data access, reporting and analytics.

Analytics refer to "the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions" (Davenport and Harris 2007, p. 7). As such, analytics represents the higher-value and more proactive end of the intelligence spectrum (Davenport and Harris 2007). Within the context of this study, analytical tools should help the firm analyze data originating from customer interactions and relationships. For instance, analytical applications such as optimization and scenario analysis help managers make sense of what customers want and need from their organization (Anderson-Lehman et al. 2004). Analytical tools such as online analytical processing and data mining also enable managers to examine trends in the data and find emerging patterns of interest.

3.1.3 Process Micro-Foundations

Scholars propose that the firm's ability to respond to market opportunities depends on the coordination and modularity of its products and processes (Dove 2001). By speeding the flow of information and reducing potential bottlenecks, well-coordinated intra- and inter-organizational processes and routines will enable the firm to quickly respond to opportunities (Malone and Crowston 1994). Thus, we examine the effects of interfunctional coordination and channel coordination on customer responding capability.

As noted in Chapter 2, the value potential of IT investments rests on their ability to interact with complementary organizational resources and capabilities. We build on this research by positing internal IS integration and external IS integration as key moderators. Internal IS integration captures the extent to which the firm's information systems provide integrated access to data across organizational sub-units. External IS integration refers to the

extent to which the IS applications of a focal firm work as a functional whole in conjunction with the IS applications of its business partners. Prior research notes that an integrated IS enhances information flow and order processing efficiency (Gattiker and Goodhue 2005; McAfee 2002). Thus, we include internal and external IS integration in our study.

3.1.3.1 Interfunctional Coordination

Interfunctional coordination refers to the degree to which a firm's functions develop a mutual understanding of each other's capabilities and align their respective goals and activities based on such understanding (Galbraith 1977). Specifically, coordination refers to managing the dependencies among activities (Malone and Crowston 1994). Organizational interdependencies arise from a number of factors such as shared resources and specialization of knowledge and expertise. Firms competing in hypercompetitive, turbulent environments with rapidly shortening product life cycles require greater coordination between functions (Hauser and Clausing 1988; Hausman et al. 2002). Furthermore, as noted in Chapter 2, market-oriented firms have well-coordinated functions and processes (Jaworski and Kohli 1993; Kirca et al. 2005). Thus, interfunctional coordination may be a critical precursor to customer agility.

3.1.3.2 Channel Coordination

Channel coordination refers to the extent to which the activities of a focal firm are coordinated with its business partners such that the processes spanning firm boundaries are operationally integrated (Van de Ven et al. 1976). In particular, channel coordination can be viewed as "the synchronization of activities and flows by channel members" (Mohr and Nevin 1990, p. 45), where channel members consist of a variety of external entities, including contract manufacturers, suppliers, subcontractors, and resource planners. Channel coordination is similar

to operational integration (Robicheaux and Coleman 1994), which is indicated by joint actions and rapid assistance with exception handling. However, low operational integration is characterized by one-time exchanges with little or no interaction or assistance after the transaction is complete. Scholars suggest that high levels of coordination with channel partners allows firms to respond more quickly to market opportunities (Haeckel 1999). Hence, channel coordination may be a critical enabler of customer agility.

As noted earlier, our study defines customers as consumers, e.g., an individual who purchases a computer from Dell. Channel partners may include a diverse range of organizational entities, such as contractors and/or suppliers. While a channel partner may be a "customer" in the language of business-to-business, our conceptualization and measurement of channel coordination excludes the term "customer" to avoid any overlap with customer agility.

3.1.3.3 Internal IS Integration

An integrated information system can link business processes together to improve visibility and information flow (Barki and Pinsonneault 2005; McAfee 2002). Standardization of data elements also leads to fewer delays and errors in order processing (Gattiker and Goodhue 2005; Goodhue et al. 1992). Integrated IS capability captures the degree to which the firm's information systems provide integrated access to data across organizational sub-units (Bharadwaj et al. 2007). By enhancing operating performance through improved access to standardized information across the value chain, an integrated IS capability should contribute to the firm's ability to capitalize on opportunities for innovation and competitive action (Davenport 2000; Haeckel 1999).

We note that internal IS integration refers to the integration of the firm's internal information systems, which are distinctly different than the web-based infrastructure discussed above. The firm's web-based infrastructure is largely at the application level (e.g., web-based tools consist of applications used by customers), yet internal IS integration is focused on the integration of the firm's internal systems. Moreover, internal IS integration may certainly link the web-based infrastructure to other information infrastructures within the firm.

Although Bharadwaj et al.'s (2007) original conceptualization of internal IS integration includes both data and process integration, we omit the process integration component and focus instead on data integration. We do so because interfunctional coordination and process integration are closely related. As noted in our literature review, interfunctional coordination is a well-established characteristic of market-oriented firms (Kirca et al. 2005); thus, we chose interfunctional coordination over process integration in this study.

3.1.3.4 External IS Integration

There are multiple approaches firms can take to achieve internal IS integration (Markus 2000). The same approaches can be used for external IS integration with suppliers, distributors and other channel partners. External IS integration is defined as the extent to which the IS applications of a focal firm work as a functional whole in conjunction with the IS applications of its business partners (Saraf et al. 2007). External IS integration can enable joint forecasting, effective inventory management, and improved transportation processes among business partners (Rai et al. 2006). Integrated interorganizational IS applications can also improve visibility and information flow, thereby facilitating the focal firm's ability to respond to market opportunities.

3.1.4 Competitive Activity

We draw from the competitive dynamics literature for our ultimate dependent variable: competitive activity. Competitive activity refers to the set of market-based moves that challenge the status quo of the market or industry through innovations in products, services, and channels (Chen 1996; Young et al. 1996). In particular, competitive activity measures how well positioned a firm is to sense customer-based opportunities and respond to them through its resources and capabilities (Sambamurthy et al. 2003).

Much of the competitive dynamics literature examines competitive interaction among firms. Ferrier et al. (1999) investigated competitive behavior among industry leaders and challengers, and Derfus et al. (2008) examined contests of competitive moves among rivalrous firms. As a result, established competitive activity measures that do not capture some aspect of inter-firm relationships are scarce. Since we intend to examine the relationship between customer agility and competitive activity, we focus on four types of competitive activity that do not depend on inter-firm relationships: the volume (number) of competitive actions, the complexity of the action repertoire, the quality of the actions made in response to customers, and the speed at which the actions are executed.

We note that competitive dynamics researchers often ignore the quality of a firm's competitive activity, instead focusing on competitive aspects like aggressiveness and rivalry (Ketchen et al. 2004). One reason for this is that much of the competitive dynamics empirical research has relied on secondary data (Duriau et al. 2007), which often limits researchers' ability to capture certain measures. One way to capture competitive action quality is to use various measures as proxies for competitive activity, such as firm performance and stock market returns

(Ferrier and Lee 2002; Lee et al. 2000). However, these proxy measures do not fully capture whether or not a firm implemented the right action at the right time. Case studies show that, in certain contexts, firms that have a slower but more concentrated and aggressive response lose less market share than firms that respond quickly (Hopkins 2003). In an effort to move beyond quantity-oriented approaches to competitive activity, we propose two new measures of competitive activity – customer response quality and customer response speed. Customer response quality is defined as the extent to which a firm executes actions which met customer needs in a given time period. Customer response speed refers to the rate at which a firm responds to customer-based opportunities for innovation and competitive action. We further describe the challenges of measuring competitive activity in the next chapter.

3.1.5 Controls

Empirical evidence shows that older firms carry out fewer total competitive actions than younger firms (Young et al. 1996). On the other hand, older firms tend to carry out more complex action repertoires than younger firms (Miller and Chen 1996). Hence, we include firm age as a control variable for competitive activity. Research suggests that large firms have simpler competitive repertoires than small firms (Miller and Chen 1996). Moreover, small firms also differ from their larger counterparts in terms of propensity for action, action execution speed and responsiveness (Chen and Hambrick 1995). Thus, we include firm size as a control variable for competitive activity. Finally, we recognize that some firms may have been adversely impacted by the 2008 economic downturn. Thus, we include an "economic impact" control variable. Table 3.2 provides definitions and supporting literature for all constructs presented in the research model.

Table 3.2. Construct Definitions

Construct	Definition	References
Customer Sensing Capability	The degree to which a firm is able to sense customer-based opportunities for innovation and competitive action	(Day 1994; Haeckel 1999; Overby et al. 2006; Sambamurthy et al. 2003; Slater and Narver 1998; Slater and Narver 2000; Zaheer and Zaheer 1997)
Customer Responding Capability	The degree to which a firm is able to respond quickly to customer-based opportunities for innovation and competitive action	
Customer Agility Alignment	The degree to which a firm's customer sensing capability is aligned with its customer responding capability	(Overby et al. 2006; Venkatraman 1989b)
Resource Infrastructure	The number of web-based tools which facilitate the customer's role as an information resource	(Jeppesen 2005; Jeppesen and Frederiksen 2006; Nambisan 2002; Prandelli et al. 2006; Sawhney and Prandelli 2000; Sawhney et al. 2005)
Cocreation Infrastructure	The number of web-based tools which facilitate the customer's role as a cocreator of products	
User Infrastructure	The number of web-based tools which facilitate the customer's role as a user of products	
Analytical Ability	The extent to which IT applications provide analytical tools to support decision-making in the context of customer interactions	(Clark et al. 2007; Davenport and Harris 2007; Negash 2004; Tippins and Sohi 2003)
Interfunctional Coordination	The degree to which a firm's functions develop a mutual understanding of each other's capabilities and align their respective goals and activities based on such understanding	(Bharadwaj et al. 2007; Galbraith 1977; Jaworski and Kohli 1993; Malone and Crowston 1994)
Channel Coordination	The extent to which the activities of a focal firm are coordinated with its business partners such that the processes spanning firm boundaries are operationally integrated	(Frazier 1999; Mohr and Nevin 1990; Mohr et al. 1996; Van de Ven et al. 1976)
Internal IS Integration	The degree to which the firm's information systems provide integrated access to data across organizational sub-units	(Barki and Pinsonneault 2005; Bharadwaj et al. 2007)
External IS Integration	The extent to which the IS applications of a focal firm work as a functional whole in conjunction with the IS applications of its business partners	(Rai et al. 2006; Saraf et al. 2007)
Action Volume	The total number of actions a firm takes in a given time period	(Ferrier 2001; Young et al. 1996)
Action Repertoire Complexity	The extent to which a firm concentrates on carrying out a broad range of action types in a given time period	(Basdeo et al. 2006; Ferrier 2001; Miller and Chen 1996)
Customer Response Quality	The extent to which a firm executes actions which met customer needs in a given time period	(Hopkins 2003; Lee et al. 2000; Smith et al. 2001)

Construct	Definition	References
Customer Response Speed	The rate at which a firm responds to customer-based opportunities for innovation and competitive action	(Chen and Hambrick 1995; Ferrier 2001)
Firm Age	Number of years since the focal firm was founded	(Chen and Hambrick 1995; Miller and Chen 1996; Young et al. 1996)
Firm Size	Number of employees employed by the focal firm	
Economic Impact	The extent to which a firm has been affected by the economic downturn	New measure

3.2 Hypothesis Development

This section explicates the specific hypotheses derived from the research model. Consistent with prior work (Zaheer and Zaheer 1997), researchers recommend that agility's two components, sensing and responding, be treated as discrete entities (Overby et al. 2006). Thus, we investigate distinct antecedents of customer sensing capability and customer responding capability.

3.2.1 Antecedents to Customer Sensing Capability

Prior research suggests that the ability to sense customer-based opportunities for innovation and competitive action depends upon the firm's ability to create, disseminate and leverage knowledge (Haeckel 1999; Sambamurthy et al. 2003; Teece 2007). We incorporate three such "knowledge-based" constructs as antecedents to customer sensing capability: web-based resource infrastructure, cocreation infrastructure and user infrastructure. We also capture how each of these resources interacts with analytical ability to further facilitate customer sensing capability.

3.2.1.1 Web-Based Infrastructure

As noted in our literature review, although customers have long been recognized as a valuable source of knowledge (Lengnick-Hall 1996; Leonard-Barton 1995; Von Hippel 1988), the

high connectivity barrier between firms and customers has prevented communication between the two. In fact, customers are often positioned at the end of the firm's value chain (Porter 1985). Hence, attempts to gain deep insight into customer innovation or other behavior associated with the firm's products and services have been cost-prohibitive.

However, new technologies such as the Internet provide a rich platform upon which firms can communicate with their customers. Firms are building web-based resource infrastructures to capture customer knowledge, suggestions and other valuable information related to the firm's products and services (Prandelli et al. 2006). In addition to reducing connectivity barriers, web-based tools allow the firm to reach a much broader and more diverse audience. For instance, Starbucks hosts a website where customers can make suggestions, other customers can vote on and discuss them, and Starbucks can see which ideas gain support (Jarvis 2008).

The creation and development of a web-based resource infrastructure lowers connectivity barriers between firms and customers, allows the firm to reach a broader and more diverse audience, and captures customer knowledge in more naturalistic settings. In doing so, the firm can gather vast amounts of information and customer knowledge, thereby gaining a better understanding of potential opportunities for innovation and competitive action. Thus, we hypothesize:

H1a: Resource infrastructure will be positively related to customer sensing capability.

A web-based cocreation infrastructure consists of tools that leverage the customers' role as cocreator. Salient cocreation tools include conjoint analysis, design toolkits, virtual

teams, and wikis (Prandelli et al. 2006). Web-based toolkits for user innovation can be developed and deployed to make product design efforts faster and less costly (Von Hippel and Katz 2002). For example, National Semiconductor offers an online toolkit called Webench (webench.national.com), a virtual design environment for circuit designers. Using tools from the Webench site, circuit designers can design and test new circuits, and can have prototype power supply kits delivered anywhere in the world in 48 hours. These toolkits can be used by communities of customers to build upon designs that have been created by other customers, as in the case of designing new games for mobile phones (Piller et al. 2004) and new modules for *The Sims* video game (Prugl and Schreier 2006).

By stimulating a two-way interactive dialogue between the firm and its customers, as well as dialogues between customers, the firm is better able to collect information concerning customer needs and preferences regarding the firm's products. Furthermore, a cocreation infrastructure facilitates rich interactions between the firm, individual customers and groups of customers. The social knowledge that arises from these interactions is invaluable to the firm's customer sensing capability. Finally, a web-based cocreation infrastructure allows the firm to reach a greater number of customers than offline product design tools, thereby exponentially increasing the size and scope of the knowledge it can absorb to better sense relevant customer-based opportunities for innovation and competitive action. Based on these arguments, we hypothesize:

H1b: Cocreation infrastructure will be positively related to customer sensing capability.

Firms can also leverage the customer's role as a user in product testing and product support in a web-based environment. Web-based tools allow the firm to involve a more diverse

set of customers in product testing, thereby achieving a better understanding of how the product would fare in a variety of user contexts (Prandelli et al. 2006). Advanced simulation and virtual reality technologies permit customers to gain a greater awareness of a product's features and limitations, which in turn constitutes valuable information to the firm.

A web-based user infrastructure also provides an environment in which customers can support each other with product-related problems (Nambisan and Baron 2007). For example, a number of software companies (e.g., Adobe, Microsoft, Oracle, SAP, Sun Microsystems) host virtual communities in which customers and software developers exchange a wealth of product support knowledge. Using the theory of "the strength of weak ties" (Granovetter 1973), research finds that information providers give useful advice and solve the problems of information seekers in electronic networks, despite their lack of a personal connection with the seekers (Constant et al. 1996). These activities may extend beyond simple product support. For instance, user-innovators often seek feedback and assistance from fellow community members on product modifications or prototypes (Franke and Shah 2003).

By testing its products and services in front of a larger and more diverse customer base, a web-based user infrastructure allows firms to better sense customer needs and preferences. Furthermore, firms can use various technologies to capture information generated by customer-to-customer product support interactions. As a result, the firm can leverage this information to improve existing products and services and potentially gain insight into other opportunities for innovation and competitive action. Thus, we hypothesize:

H1c: User infrastructure will be positively related to customer sensing capability.

3.2.1.2 Moderating Role of Analytical Ability

While the web-based infrastructure facilitates the generation of vast amounts of customer data and information, analytical tools help the firm make sense of this wealth of data (Davenport and Harris 2007). Firms can leverage analytical tools such as data mining to find patterns in data, thereby gaining insight and understanding into potential opportunities for innovation and action. Explanatory and predictive models can be employed to simulate what-if scenarios and different combinations of responses the firm could make to market opportunities (Anderson-Lehman et al. 2004; Singh and Sawhney 2006). Analytical software can be used to track and manage customer transactions and interactions to identify the right offer to a customer at the right time (Gessner and Volonino 2005). Data and information streaming into the firm from the web-based infrastructure may create an overwhelming glut that is difficult for managers to interpret, synthesize and understand (Keller and Staelin 1987; Miller 1956). Firms with higher levels of analytical ability will be better able to gain insight into the data generated by all three types of web-based infrastructures (resource, cocreation and user). Thus, we hypothesize:

H2a: The relationship between resource infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between resource infrastructure and customer sensing capability.

H2b: The relationship between cocreation infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between cocreation infrastructure and customer sensing capability.

H2c: The relationship between user infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between user infrastructure and customer sensing capability.

3.2.2 Antecedents to Customer Responding Capability

Literature suggests that the firm's ability to respond to customer-based opportunities for innovation and competitive action depends upon the coordination of its functional units and external partners (Dove 2001; Teece 2007). We incorporate two such "process-based" constructs as antecedents to customer responding capability: interfunctional coordination and channel coordination. Moreover, we propose that internal IS integration and external IS integration will each play a moderating role in these relationships.

3.2.2.1 Interfunctional Coordination

The dissemination of market intelligence throughout the organization depends largely upon the extent to which organizational functions are connected to and coordinated with each other (Jaworski and Kohli 1993; Kennedy et al. 2003). Moreover, the firm's ability to respond to shifts in customer preferences is dependent upon efficient and effective coordination between organizational functions (Dove 2001; Jaworski and Kohli 1993). Aligned processes facilitate the flow of information throughout the organization, thereby increasing the organization's ability to respond to external opportunities. For instance, high levels of coordination between manufacturing and marketing leads to: (1) reduced task uncertainty for both functions (Galbraith 1977), (2) greater understanding by marketing of manufacturing's constraints, objectives and incentives (Hausman et al. 2002), and (3) greater understanding by manufacturing of customer preferences, marketing plans and competitive activity (Kohli and

Jaworski 1990). The greater the extent to which organizational functions are coordinated, the more they are likely to respond to customer-based opportunities in a concerted fashion. Based on this reasoning, we hypothesize:

H3: Interfunctional coordination will be positively related to customer responding capability.

3.2.2.2 Channel Coordination

In addition to relying upon the effective coordination of internal units, firms must also effectively coordinate with external channel partners if they wish to respond quickly to market opportunities. Aligned inter-organizational processes enhance the flow of information between the focal firm and its key channel partners (Patnayakuni et al. 2006). The greater the extent to which a firm coordinates with its channel partners, the easier it is for the firm to mobilize its own resources and capabilities in response to customer-based opportunities. Based on this reasoning, we hypothesize:

H4: Channel coordination will be positively related to customer responding capability.

3.2.2.3 Moderating Role of Internal IS Integration

As noted in our review of the IT value literature, scholars are increasingly beginning to view information systems as complementary resources that enhance the value of other organizational resources and capabilities (Brynjolfsson and Hitt 2000; Tanriverdi 2006; Tippins and Sohi 2003). Interfunctional coordination represents an alignment of goals and behaviors contingent on mutual understanding, trust and partnership. Integrated information systems greatly enhance interfunctional exchanges and promote joint understanding. Prior work finds that integrated IS capability interacts with various coordination mechanisms (e.g.,

manufacturing-marketing, manufacturing-supply chain) to increase manufacturing performance (Bharadwaj et al. 2007). By providing features such as automatic updates of data records through system wide triggers, a consistent view of the data, and facilities for quickly reporting and sharing relevant information across functional boundaries, these systems are more likely to increase the flow of information throughout the entire organization (Barki and Pinsonneault 2005; Davenport 2000). As a result, the firm can more quickly respond to customer-based opportunities for innovation and competitive action. Thus, we hypothesize:

> *H5: The relationship between interfunctional coordination and customer responding capability will be moderated by internal IS integration: the greater the internal IS integration, the stronger the positive association between interfunctional coordination and customer responding capability.*

3.2.2.4 Moderating Role of External IS Integration

The argument positing the existence of synergistic value derived from interfunctional coordination and internal IS integration holds for the interactive effect of channel coordination and external IS integration. External IS integration improves firms' ability to process orders, forecast sales, share customer data, and collaborate in areas such as new product development (Rai et al. 2006). By providing features such as a consistent view of the data and facilities for seamlessly sharing relevant information across organizational boundaries, these systems are more likely to increase the flow of information across distribution channels. As a result, the focal firm can more quickly respond to customer-based opportunities for innovation and competitive action. Thus, we hypothesize:

H6: The relationship between channel coordination and customer responding capability will be moderated by external IS integration: the greater the external IS integration, the stronger the positive association between channel coordination and customer responding capability.

3.2.3 Customer Agility, Agility Alignment and Competitive Activity

Competitive activity consists of market-based moves that challenge the status quo of the market or industry through innovations in products, services, and channels (Chen 1996; Smith et al. 2001). Firms that possess a more complex set of resources and capabilities will be in an advantageous position to launch competitive actions (Dove 2001; Ferrier et al. 1999). By sensing and responding to customer-based opportunities, firms will be more likely to exhibit greater levels of competitive activity (Sambamurthy et al. 2003). Thus, customer agility should be positively related to competitive activity. Yet we do not postulate this hypothesis; rather, we take into account a firm's degree of alignment between its customer sensing capability and customer responding capability. As noted earlier, we consider three perspectives on agility alignment: alignment as moderation, matching and mediation. We investigate each of these alignment perspectives on four measures of competitive activity: action volume, action repertoire complexity, customer response quality, and customer response speed.

3.2.3.1 Action Volume

Action volume refers to the total number of a firm's actions in a given time period. When conceptualizing the relationship between agility alignment as moderation and action volume, let us consider two direct competitors: Firm A and Firm B. Firm A has a stronger customer sensing capability than Firm B; thus, Firm A is able to sense more customer-based

opportunities than Firm B. Let us suppose that, over a period of one year, Firm A senses ten opportunities, and Firm B senses only five opportunities. By sensing more opportunities, Firm A is more likely to implement its customer responding capability and take more competitive action. Thus, the relationship between customer responding capability and action volume will be stronger when customer sensing capability is high. Hence, we hypothesize:

> *H7a: The relationship between customer responding capability and action volume will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and action volume.*

The relationship between agility alignment as matching and action volume is not clear. Let us suppose that Firm A has high customer sensing capability and high customer responding capability, and Firm B has low customer sensing capability and high customer responding capability. In this case, Firm A is aligned (high-high), and Firm B is non-aligned (low-high). Action volume only captures the quantity of actions taken in a given time period; it does not capture the appropriateness or quality of an action. Thus, we do not know if Firm B (low sense, high response) is responding to the right opportunity at the right time. In fact, Firm B may be undertaking similar levels of action volume as Firm A (high sense, high response). Yet Firm A is aligned in its customer agility processes while Firm B is not aligned. This analysis shows us that agility alignment as matching and competitive activity are not related when competitive activity is defined and measured in terms of "quantity" as opposed to "quality" of competitive actions. Thus, we do not hypothesize a relationship between agility alignment as matching and action volume.

Finally, we consider the relationship between agility alignment as mediation and action volume. We propose an indirect effect of customer sensing capability on action volume through the mediating role of customer sensing capability. Following the process view of dynamic capabilities (Teece 2007), a firm's ability to respond to market opportunities is dependent on its ability to sense those opportunities. Moreover, a firm must have a minimum ability to respond in order to take action. Thus, as the sense-respond-action process unfolds, the relationship between customer sensing capability and action volume will be at least partially mediated by the firm's customer responding capability. These arguments suggest an indirect impact of customer sensing capability on action volume through customer responding capability.

H7b: Customer responding capability mediates the impact of customer sensing capability on action volume.

3.2.3.2 Action Repertoire Complexity

Action repertoire complexity captures the extent to which a firm concentrates on carrying out a broad range of action types in a given time period. Let us continue the previous example, where Firm A has a higher sensing capability than Firm B yet their responding capabilities are equal. Based on the literature reviewed in Chapter 2, customer sensing capability takes into account customers' expressed and latent needs (Narver et al. 2004). Since Firm A is able to more effectively sense customers' expressed and latent needs relative to Firm B, Firm A is more likely to sense a diverse range of customer-based opportunities than Firm B. By sensing a more diverse variety of opportunities, Firm A is in a better position to respond to a greater variety of opportunities, thereby increasing its overall action repertoire complexity. However, the firm's ability to translate a variety of sensed opportunities into action is again

dependent on its ability to respond to those opportunities. Thus, as the sense-respond-action process unfolds, the relationship between customer sensing capability and action repertoire complexity will be mediated by customer responding capability. These arguments lead to the following hypotheses:

H8a: The relationship between customer responding capability and action repertoire complexity will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and action repertoire complexity.

H8b: The higher the "match" between customer sensing capability and customer responding capability, the higher the action repertoire complexity.

H8c: Customer responding capability mediates the impact of customer sensing capability on action repertoire complexity.

3.2.3.3 Customer Response Quality

While competitive activity often focuses on the quantity of actions a firm takes in a given time period, it is also important to recognize whether or not those actions meet or exceed customers' needs. We define customer response quality as the extent to which a firm executes actions which met customer needs in a given time period. While a firm may appropriately respond to customer-based market opportunities in a timely manner, the relationship between customer responding capability and customer response quality will likely be strengthened by customer sensing capability. Firms with strong sensing capabilities are able to effectively sense what their customers really want in terms of products and services (Kohli and Jaworski 1990).

They also develop new ways of looking at customers and their needs. As a result, these firms are more likely to detect opportunities which translate to customer value and, in the long term, greater firm performance.

H9a: The relationship between customer responding capability and customer response quality will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and customer response quality.

The matching perspective of agility alignment is especially relevant to customer response quality. Firms can have strong responding capabilities, but fail to sense market opportunities. For instance, as noted in Chapter 2, Apple introduced the Newton, a personal digital assistant (PDA), to the mass market when, in fact, it was too early in its development for the Newton to be made generally available. As a result, the Newton lost its audience and never again gained traction in the PDA market (Bayus et al. 1997). On the other hand, firms might be able to sense customer-based opportunities for competitive action but fail to respond to them in an agile manner. For example, poorly coordinated processes may hinder product development activities, causing firms to miss market opportunities. Furthermore, firms which have strong sensing and responding capabilities are more likely to execute actions which meet customers' needs. Hence, we hypothesize:

H9b: The higher the "match" between customer sensing capability and customer responding capability, the higher the customer response quality.

The matching argument above also applies to the mediation perspective of agility alignment. A firm's ability to respond to appropriate (i.e., "the right") market opportunities is dependent on its ability to effectively determine customers' needs. A firm must first sense the right opportunities, then translate these opportunities into new products and services which effectively meet customers' needs. Hence, as a firm carries out the sense-respond-action process, the relationship between customer sensing capability and customer response quality will be mediated by the firm's customer responding capability.

H9c: Customer responding capability mediates the impact of customer sensing capability on customer response quality.

3.2.3.4 Customer Response Speed

One element of customer agility is the speed at which firms respond to their customers. We define customer response speed as the rate at which a firm responds to customer-based opportunities for innovation and competitive action. While agile firms are able to respond rapidly if something happens with regard to their customers (Day 1994; Slater and Narver 2000), it is not clear if a firm's customer sensing capability is important for response speed. Prior research finds that firms may be better off waiting to respond to market changes (Hopkins 2003). A firm with a strong sensing capability might actually wait until further developments take place regarding customers, competitors or other environmental factors before taking action or not taking action. Hence, while a strong responding capability implies quick response speed, we do not expect agility alignment, as moderation or matching, to impact customer response speed.

From a process perspective, a firm can only respond to opportunities as fast as it can sense those opportunities. Thus, a firm must be able to sense customer-based opportunities quickly if it is to respond in a timely manner. Furthermore, a firm cannot execute sensed opportunities quickly if it has a weak responding capability. Hence, the relationship between customer sensing capability and customer response speed will be mediated by customer responding capability. To put it succinctly, the sense-respond-action process will only be executed as fast as the "weakest link" allows. Based on these arguments, we hypothesize:

H10: Customer responding capability mediates the impact of customer sensing capability on customer response speed.

3.3 Chapter Summary

In this chapter we formally introduced the research model, defined the constructs and proposed the hypotheses. The research model builds upon a synthesis of the research presented in Chapter 2. Specifically, we propose that web-based resource infrastructure, cocreation infrastructure and user infrastructure are main antecedents to customer sensing capability. Furthermore, these relationships will be moderated by analytical ability. Antecedents to customer responding capability include interfunctional coordination and channel coordination. Internal IS integration is conceptualized as a moderator of the relationship between interfunctional coordination and customer responding capability, and external IS integration is proposed to be a moderator of the relationship between channel coordination and customer responding capability.

The second half of the research model proposes that customer agility affects competitive activity. However, the full effect of customer agility on competitive activity will take place when a firm's customer sensing capability and customer responding capability are in alignment. We conceptualized three types of agility alignment: moderation, matching and mediation. Furthermore, we hypothesized the relationship between agility alignment and four measures of competitive activity: action volume, action repertoire complexity, customer response quality, and customer response speed. Table 3.3 provides a list of the proposed hypotheses. In the next chapter we discuss how the research model will be empirically tested.

Table 3.3. Hypotheses

Item	Hypothesis
H1a	Resource infrastructure will be positively related to customer sensing capability.
H1b	Cocreation infrastructure will be positively related to customer sensing capability.
H1c	User infrastructure will be positively related to customer sensing capability.
H2a	The relationship between resource infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between resource infrastructure and customer sensing capability.
H2b	The relationship between cocreation infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between cocreation infrastructure and customer sensing capability.
H2c	The relationship between user infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between user infrastructure and customer sensing capability.
H3	Interfunctional coordination will be positively related to customer responding capability.
H4	Channel coordination will be positively related to customer responding capability.
H5	The relationship between interfunctional coordination and customer responding capability will be moderated by internal IS integration: the greater the internal IS integration, the stronger the positive association between interfunctional coordination and customer responding capability.
H6	The relationship between channel coordination and customer responding capability will be moderated by external IS integration: the greater the external IS integration, the stronger the positive association between channel coordination and customer responding capability.

Item	Hypothesis
H7a	The relationship between customer responding capability and action volume will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and action volume.
H7b	Customer responding capability mediates the impact of customer sensing capability on action volume.
H8a	The relationship between customer responding capability and action repertoire complexity will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and action repertoire complexity.
H8b	The higher the “match” between customer sensing capability and customer responding capability, the higher the action repertoire complexity.
H8c	Customer responding capability mediates the impact of customer sensing capability on action repertoire complexity.
H9a	The relationship between customer responding capability and customer response quality will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and customer response quality.
H9b	The higher the “match” between customer sensing capability and customer responding capability, the higher the customer response quality.
H9c	Customer responding capability mediates the impact of customer sensing capability on customer response quality.
H10	Customer responding capability mediates the impact of customer sensing capability on customer response speed.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.0 Introduction

In this chapter we describe methods used to test the validity of our research model. First we discuss the research design, including unit of analysis, key informant, target sample frame, sample size, and survey administration. Then we describe measures for the constructs in our research model. In particular, we derive measurement items, both survey-based and content-based, from prior literature, and we also discuss the underlying structure of each construct (formative or reflective). Finally, we explain our plan for data analysis, including the preparation phase, measurement validation and structural validation.

4.1 Research Design

The goal of this study is to develop a model for customer agility and understand the relationships among IT-enabled resources, organizational factors, customer agility, and competitive activity. We will use two data collection approaches: survey and Internet. Since we hope to explain variance and develop causal relationships, we will use a variety of techniques – linear regression, polynomial regression, and structural equation modeling – to test the validity of the proposed research model. Furthermore, we employ a longitudinal design to strengthen our arguments for causality. Figure 4.1 depicts the entire research design process.

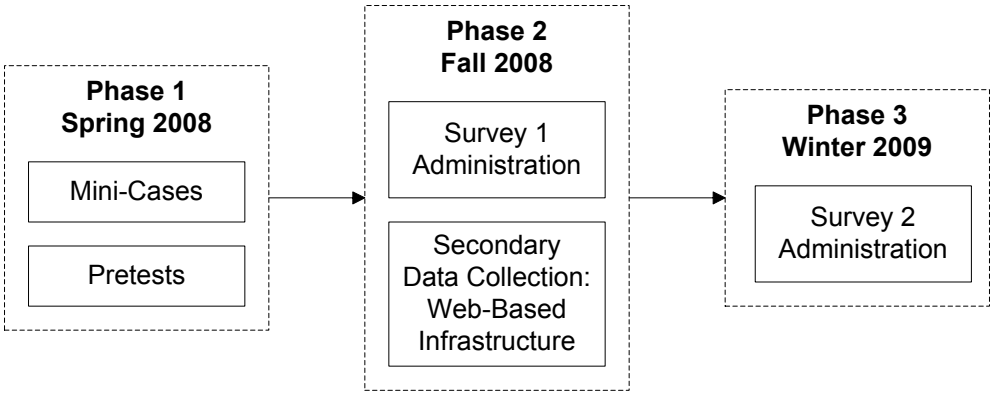


Figure 4.1. Research Design Phases

Phase 1 consists of mini-case studies and pretests for measures of web-based infrastructure. Phase 2 consists of two full-scale data collection efforts: survey administration and secondary data collection of web-based infrastructure tools. In Phase 3 we will administer a second survey (to the same respondents) to collect data for competitive activity measures.

Realized value from IT investments could take years due to the realities of IT adoption, implementation, acceptance, and diffusion (Santhanam and Hartono 2003). Hence, there is a need in the IS literature to examine longitudinal firm-level data to observe the lagged effects of IT-based value (Devaraj and Kohli 2003). Based on this reasoning, Phase 2 and Phase 3 will be temporally separated. This longitudinal design will also enhance our arguments for causality regarding the relationship between customer agility and competitive activity.

In the following section we describe three mini-cases. These mini-cases provide insight into several areas of our study, including face validity of the research model, who our key informant should be, an appropriate context (i.e., industry) in which to test the research model, and how we can measure our principal constructs.

4.1.1 Mini-Cases

Exploratory interviews based on a case study technique were employed to obtain qualitative data regarding the pragmatic aspects of the research model (Creswell 1994; Kaplan and Duchon 1988). An open ended interview technique (Miles and Huberman 1994; Yin 1994) was employed to collect data directly from three respondents during the Spring of 2008.

4.1.1.1 Mini-Case 1

One 45 minute interview was conducted with an Account Manager at a large U.S. based rental car firm, hereafter referred to as "Omicron". The respondent managed fleets of automobiles for commercial and non-commercial customers. Omicron's Fleet Management unit is capable of handling all aspects of automobile management, including vehicle acquisition, maintenance, fuel, licensing, registration, insurance, and financing. Furthermore, customer service is a top priority for Omicron.

The respondent noted that Omicron uses multiple mechanisms to collect information from customers, such as face-to-face interactions, call centers and online surveys. Omicron also uses analytical software to better understand customers' needs and preferences. Since Omicron is constantly trying to retain customers and persuade customers to upgrade their contracts with Omicron, the respondent remarked that Omicron strives to gain insight into customers' latent needs. Also, using analytical tools to develop insight is one of Omicron's key capabilities.

Omicron's respondent also discussed the importance of interfunctional coordination and communication, both of which are critical to response time with respect to customers. Moreover, Omicron has a well-honed IS department which provides ready access to all of the data the respondent and the respondent's team needs to be able to make decisions and

implement tactical plans. Hence, coordination, communication and integration are key elements to Omicron's responding capability.

There are a number of key findings from this interview. First, Omicron uses a limited number of web-based tools to solicit customer involvement in NPD processes. Instead, it appears that Omicron relies upon face-to-face interactions between its employees and customers to gain customer feedback on products and services. However, Omicron does make extensive use of analytical software to gain insight into emerging customer preferences and needs. Second, interfunctional coordination and communication are central to Omicron's ability to respond to market opportunities and shifts in customer preferences. The respondent also noted that organizational members have ready access to a wide variety of data and information concerning customers, competitors, suppliers, and other relevant sources.

Finally, while the respondent noted that Omicron's competitive actions are often a result of numerous decisions that originate from many sources of information, Omicron has taken actions based on customer input. For instance, after receiving a significant amount of customer input and feedback, Omicron launched a Service Quality Index program to systematically assess customer satisfaction. The use of this program has greatly increased Omicron's performance since its inception just a few years ago. This anecdotal evidence provides support for the links among customer sensing capability, customer responding capability, competitive activity, and eventual firm performance.

4.1.1.2 Mini-Case 2

One 30 minute interview was conducted with a Director of Subscriptions at a small U.S. based online research firm, hereafter referred to as "Epsilon". The respondent managed

customer subscriptions to Epsilon's online library, which offers millions of magazine, newspaper, journal, and other research articles to individuals. With only 45 employees, Epsilon is much smaller than Omicron (over 65,000 employees). However, Epsilon appeared to be much more active in trying to seize market opportunities and achieve growth within its competitive niche market.

Similar to Omicron, the respondent for Epsilon noted that the firm uses multiple mechanisms to collect information from customers, such as online surveys, user testing, user panels, and web-tracking behavior. Epsilon also uses analytical software to find patterns in the data obtained from the web-tracking mechanisms and online surveys. The respondent noted that the management team often combined these analytical reports with its own experience and insight to make decisions concerning potential market opportunities. Epsilon would like to implement more online mechanisms to collect information from customers, but making such projects a priority is difficult in their fast-paced environment. Instead, responding to opportunities takes precedent. Finally, the respondent for Epsilon also noted the importance of inter-functional coordination and communication; however, coordination and communication were usually not a problem due to the firm's small size.

There are a number of key findings from this interview. First, Epsilon uses a number of web-based tools to solicit customer involvement in NPD processes, such as online questionnaires, polls, blogs, and suggestion boxes. These tools appear to be concentrated at the input side of the NPD process. Thus, Epsilon primarily views the customer as a resource of information concerning new and improved products and services. However, Epsilon does release beta versions of new products and services to be specifically tested by customers.

Hence, Epsilon also leverages the customer's role as a user in NPD. Also, similar to Omicron, Epsilon relies on analytical tools to help its managers find patterns and emerging trends in customer behavior, thereby sensing potential opportunities for innovation and competitive action.

Epsilon's functions are well-coordinated and have ready access to numerous integrated data sources. As a result, they are positioned to respond to market opportunities. Epsilon is an online reference service, which places it in a relatively dynamic environment. Hence, the respondent remarked that Epsilon is continuously sensing and responding to opportunities for innovation and competitive action. One customer-based action taken by Epsilon was its release of a "Blog Enhancer" – a tool that allows a customer to link an article from Epsilon's repository to his/her personal blog web site. Epsilon released its Blog Enhancer tool as a beta version to twenty bloggers to gain deeper understanding into the features and possible limitations of the tool. The information gained in the beta process proved valuable in developing an improved version of the Blog Enhancer tool. This anecdotal evidence provides support for the links among customer sensing capability, customer responding capability and competitive activity.

4.1.1.3 Mini-Case 3

One 60 minute interview was conducted with a Marketing Consultant at a U.S. based market research firm. The respondent had over twenty years of experience consulting numerous companies on marketing policy and practice. The respondent also specialized in technology-enhanced marketing. Thus, this individual was in a unique position to substantially contribute to our understanding of IT-enabled customer relationships.

The respondent noted that, based on her consulting experience, many contemporary organizations are actually overwhelmed with the rapid explosion of information technologies that can connect companies to consumers. While managers are starting to embrace some of these technologies, such as blogs and wikis, they are also taking a wait-and-see approach to others, such as Second Life (www.secondlife.com). The respondent spent a great deal of time discussing the importance of information technologies that facilitate social aspects. For example, rigid "quantitative" web-based tools such as structured feedback surveys fail to truly tap into customer desires and preferences. In contrast, "qualitative" tools, such as blogs and bulletin boards, are much more effective at facilitating social ties and a greater awareness of customer feelings and preferences. She noted that several firms are starting to formulate portfolios of web-based tools that enhance "quantitative" analysis of customer preferences as well as "qualitative" aspects of customer behavior.

Key findings from this interview relate to the left-hand side of our research model. In particular, the respondent discussed how many firms are using a variety of web-based tools to solicit customer involvement in NPD processes. These tools may be broad in reach, e.g., online surveys, or high in richness, e.g., customer forums. Furthermore, firms are using these tools to sense changes in customer needs and preferences. The respondent also noted that many managers have yet to fully adopt some of these web-based technologies. Yet those that have tend to work for organizations operating in a variety of industries, such as consumer packaged goods, automotive, and high-tech. This mini-case provides support for the link between web-based infrastructure and customer sensing capability. Table 4.1 summarizes findings from the mini-cases and how they contribute to our understanding of IT resources, customer agility and

competitive activity. In the following sections we describe the unit of analysis, key informant, target sample frame, desired sample size, and survey administration.

Table 4.1. Summary of Mini-Cases

Mini-Case	General Contributions to our Study	Support for Relationships in Research Model
Case 1 (Omicron)	The use of analytical tools is critical to gain insight into customers' expressed and latent needs and preferences. Coordination (both internal and external) and integrated information systems are key enablers of customer responding capability. Competitive actions have also been taken based on customer feedback and input.	• Analytical ability and customer sensing capability • Interfunctional coordination and customer responding capability • Channel coordination and customer responding capability • IS integration and customer responding capability • Customer agility and competitive activity
Case 2 (Epsilon)	Multiple web-based tools are employed to interact with and collect data from customers. Analytical tools are used to help managers make sense of this data. Interfunctional coordination and integrated IS both facilitate the firm's ability to respond to opportunities. Competitive actions have been executed with the help of customer input and feedback.	• Web-based infrastructure and customer sensing capability • Analytical ability and customer sensing capability • Interfunctional coordination and customer responding capability • Internal IS integration and customer responding capability • Customer agility and competitive activity
Case 3	Organizations are leveraging quantitative and qualitative web-based tools to interact with customers. Furthermore, these tools may be high in reach or richness.	• Web-based infrastructure and customer sensing capability • Analytical ability and customer sensing capability

4.1.1 Unit of Analysis

The unit of analysis is a strategic business unit. Respondents will be instructed to respond to the instrument questions with respect to their organization.

4.1.2 Key Respondent

Managers play a critical role in the effective orchestration and utilization of organizational resources and capabilities (Helfat et al. 2007; Teece 2007). Thus, we contend that key managers will possess a sufficient understanding of how well their organization senses and responds to its customers (in addition to other survey-based constructs). Following prescribed guidelines (Huber and Power 1985), marketing managers constitute the most informed respondent for this study. Prior studies show that these individuals are in the best position to assess how well the organization senses and responds to its customers (Homburg et al. 2007; Narver et al. 2004). Our interviews with practitioners also showed that marketing managers are the most informed respondent for our study. Moreover, the IT-based constructs (internal IS integration, analytical ability) address the effectiveness of IT within the organization, not technical details related to the technology. Marketing managers will also be the most informed about IT that faces customers, i.e., web-based tools. Hence, marketing managers are informed enough to address IT-related measures in addition to organizational factors.

4.1.3 Target Sample Frame

To determine the suitable population of interest in this study, we developed a list of criteria based on prior research and the findings from our mini-cases.

- First, we need to investigate firms operating in dynamic, customer-oriented, information-intensive environments. These firms are more likely to require high levels of customer agility (Haeckel 1999; Sull 2009).

- Consistent with competitive dynamics research, we target only public U.S. firms (Derfus et al. 2008; Ferrier et al. 1999).

- Third, our target sample frame should include firms that have adopted and diffused a diverse range of web-based tools which support customer innovation in product development. Research suggests firms operating in high tech industries as excellent candidates (Porter and Donthu 2008; Prandelli et al. 2006).

- Finally, the results of our mini-cases also support our decision to investigate high tech firms. For example, firms competing in dynamic, information-intense industries, e.g., Epsilon, subscribe to our criteria more so than firms operating in stable industries, e.g., Omicron.

Based on these criteria and findings, our target sample frame will consist of public U.S.-based firms operating in high tech industries – specifically the computer manufacturing and prepackaged software. Although limiting our target sample frame to these industries may reduce our study's generalizability, investigating phenomena in a limited number of contexts is typical in the early stages of research into a phenomena of interest (Colquitt and Zapata-Phelan 2007; Weick 1995). While a number of case studies have provided insight into customer agility, to the best of our knowledge this is the first full-scale empirical study of how IT facilitates customer agility and, in turn, competitive activity.

4.1.4 Sample Size

The power of a statistical test is the probability that the test will detect an effect in a sample size when, in fact, a true effect exists in the population (Cohen 1988). It is important to note that since we are not formally proposing mediation (with the exception of agility alignment), we will not test our complete research model in one single analysis. Instead, we will test the validity of three distinct models, each of which are displayed in Figure 4.2.

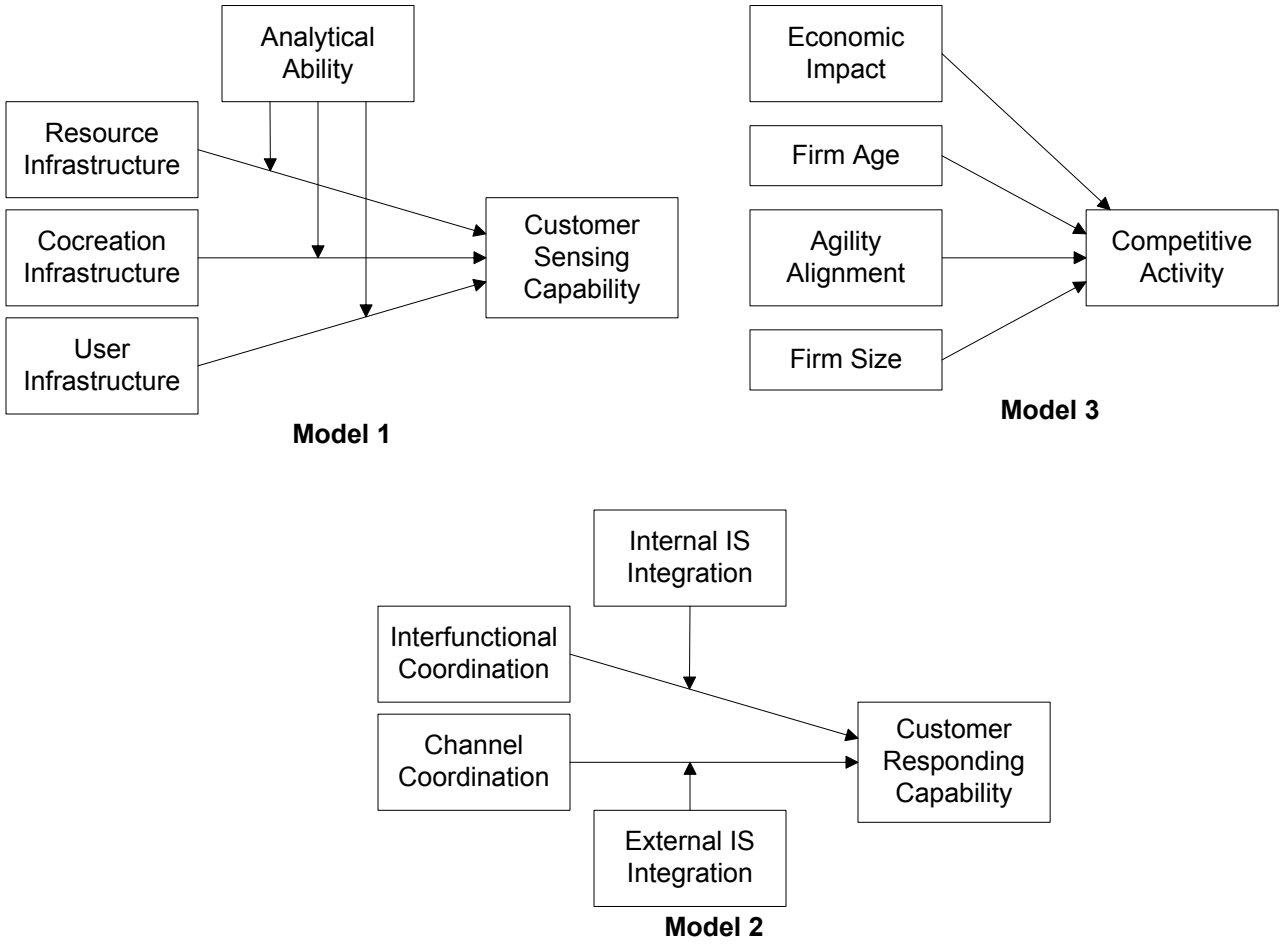


Figure 4.2. Models to be Tested

Based on this disaggregation of the research model, we conduct our power analyses for the model which requires the largest sample size, i.e., the one with the greatest number of independent variables. Model 1 has six IVs (three main effects plus three interaction effects); Model 2 has four IVs (two main effects plus two interaction effects); and Model 3 has four IVs (three main effects plus one interaction effect). Hence, we conduct our power analyses for Model 1.

Four factors must be specified to determine the necessary sample size for tests which include interaction effects (Jaccard et al. 1990). First, one must specify the desired level of power of the statistical test. We adopt Cohen's (1988) recommended guideline of 0.80. Second, one must specify the Type I error rate (alpha level) for the test. Consistent with prior IS research, we set our alpha level at 0.05. Third, one must estimate what the population squared multiple correlation is for the model with only main effects, and, fourth, one must estimate the population squared multiple correlation for the "full" model that includes the interaction term. The difference between these two tests is the estimated strength of the interaction effect (Maxwell 2000). While the latter two estimates can be based on previous research, theoretical guidelines, and/or pilot research, they are often difficult for researchers to make (Jaccard et al. 1990). Since very little prior work has empirically examined the relationships among these constructs, we err toward conservatism and an increased sample size by assuming relatively small squared multiple correlations and interaction effects in the population. We conduct a scenario analysis for two different estimates of correlations among variables.

Scenario 1: If the average correlations among IVs are 0.30 and the average correlation between an IV and a DV is 0.20, the required sample size is 180.

Scenario 2: If the average correlations among IVs are 0.40 and the average correlation between an IV and a DV is 0.25, the required sample size is 230. Going with the more conservative estimate, the desired sample size is 230.

4.1.5 Survey Administration

Both surveys will be administered through Zoomerang, a national market research firm (www.zoomerang.com). Zoomerang provides respondents who participate in various research studies. Over 3 million members exist in this research panel (hereafter referred to as Zoompanel), and these members are profiled across 500 attributes. Zoomerang reports that the profile of their member panel is representative of the U.S. population. There is evidence that these types of data collection approaches are used in academic research (Piccolo and Colquitt 2006; Porter and Donthu 2008).

Individuals that belong to Zoompanel have double opted into the panel to participate in surveys. Double opt-in implies that panelists sign up and are then given an opportunity to withdraw from the panel, ensuring that they really do want to participate. Panelists are provided with incentive points for each survey that they complete. This is similar to the incentives often given to complete an instrument in traditional mail surveys where mailings are made to a directory (sample frame) of participants.

Zoomerang employs several quality assurance mechanisms to maintain the quality of their respondent panel. For instance, the information that panelists provide (e.g., demographics) are verified against extensive databases with validated consumer demographics. Another mechanism takes into account survey-taking time and response patterns to identify fraudulent

behavior. This type of data collection can provide greater control based on the selected attributes.

Although Zoomerang profiles its panel of respondents, thereby enabling us to target marketing managers, the profile may be outdated. For instance, a respondent's profession/job title at the time of completing this survey might be different than when he/she joined the respondent panel. Therefore, we will use screening questions to gain better control over our sample frame. Additionally, we will assess the respondent's competency in addressing the questionnaire. According to the sample frame requirements, a number of screening/competency questions will be developed:

1. What is your current job title?
2. How many years have you been with this organization?
3. How many years have you been in your current position?
4. How active are you currently in formulation of marketing/sales policies of your organization?
5. Please indicate your organization's primary industry category.

These questions enable us to target full-time working marketing managers who have adequate knowledge regarding customer relationships in their organization. Furthermore, we are able to ensure that we are surveying firms operating in high tech environments.

4.2 Construct Measurement

Measurement properties of constructs will be developed and assessed in terms of dimensionality, reliability, and validity (Churchill 1979; Straub et al. 2004). Where possible existing measures of constructs will be adapted to this study's context. For new measures and those that will require significant changes, standard scale development procedures will be used (Churchill 1979). Secondary data will also be used where possible to test the convergent validity of perceptual (i.e., survey-based) measures. This section describes measurement items for the constructs proposed in the research model. We also detail our approach to modeling these constructs (i.e., formative or reflective).

4.2.1 Measurement Items: Survey One

We measured the following constructs in our first survey: customer sensing capability, customer responding capability, web-based infrastructure, analytical ability, interfunctional coordination, channel coordination, internal IS integration, external IS integration, firm size, firm age, and all respondent demographics.

4.2.1.1 Customer Sensing Capability

Customer sensing capability is defined as the degree to which a firm is able to sense customer-based opportunities for innovation and competitive action. Our measure of customer sensing capability is derived from Narver et al. (2004) and Slater and Narver (2000). The items are shown in Table 4.2.

Table 4.2. Items for Customer Sensing Capability

Item #	Item
CS1	We continuously try to discover additional needs of our customers of which they are unaware.
CS2	We work closely with lead users who try to recognize customer needs months or even years before the majority of the market may recognize them.
CS3	We extrapolate key trends to gain insight into what users in a current market will need in the future.
CS4	We continuously try to anticipate our customers' needs even before they are aware of them.
CS5	We attempt to develop new ways of looking at customers and their needs.
CS6	We sense our customers' needs even before they are aware of them.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.*	

4.2.1.2 Customer Responding Capability

Customer responding capability is defined as the degree to which a firm is able to respond quickly to customer-based opportunities for innovation and competitive action. Our measure of customer responding capability is derived from three sources (Homburg et al. 2007; Jayachandran et al. 2004; Kohli et al. 1993). The items are provided in Table 4.3.

Table 4.3. Items for Customer Responding Capability

Item #	Item
CR1	We respond rapidly if something important happens with regard to our customers.
CR2	We quickly implement our planned activities with regard to customers.
CR3	We quickly react to fundamental changes with regard to our customers.
CR4	When we find that customers would like us to modify a product or service, our organization makes concerted efforts to do so.
CR5	When we identify a new customer need, we are quick to respond to it.
CR6	We are fast to respond to changes in our customers' product or service needs.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.*	

4.2.1.3 Agility Alignment

As discussed in Chapter 3, our measure for agility alignment is based on the fit between customer sensing capability and customer responding capability. From a moderation perspective, we compute agility alignment as an interaction term based on customer sensing capability and customer responding capability. In line with prior alignment research (Chan et al. 1997) and methodological recommendations (Aiken and West 1991), all indicators will be mean-centered prior to calculating interaction terms. From a matching perspective, we use polynomial regression (Edwards 1994; Edwards and Parry 1993) to assess the relationship between customer agility and competitive activity. Finally, we follow recommended guidelines to test for agility alignment as mediation (Baron and Kenny 1986; MacKinnon et al. 2002).

4.2.1.4 Web-based Infrastructure

Web-based infrastructure tools represent the online mechanisms that organizations can adopt to interact with customers in order to support different customer NPD roles. We will measure web-based infrastructure by asking respondents whether or not their organization makes a particular web-based tool available to its customers through its web site. As opposed to identifying and coding observable web-based tools, thereby making the analysis more objective, we have to collect this data from respondents for two reasons. First, respondents may not provide their organization's web site address. Second, as discovered in our exploratory interviews, not all web-based tools may be available on the organization's public web site. Some tools may only be available to registered users; in more restrictive cases, some tools may only be available to subscribing or paying customers. However, we will triangulate our primary data collection with secondary data where respondents make their organization's web site address known.

Prior research has assessed web-based infrastructure with a weighted approach in which each variable or web-based tool is described by using a number of different attributes (Prandelli et al. 2006). Indexes are provided that incorporate the information collected in the single attributes for each variable identified. The indexes are created by giving the same weight to each attribute. Each attribute has a value of 1 if present and 0 if absent. For each organization, the sum of all the attributes considered per variable makes it possible to compute absolute indexes, which are subsequently relativized. Each variable is described by means of seven attributes: 1) simple presence, 2) use targeted to web site innovation, 3) use targeted to service innovation, 4) use targeted to product innovation, 5) presence of pre-defined leading topics, 6) offer of monetary incentives, and 7) offer of non-monetary incentives.

However, results of our web-based infrastructure pretest and mini-cases found that this method is unclear and sometimes confusing. Some web-based tools are not amenable to one or more of the specified attributes. For instance, customer forums may include conversations related to web site innovation, service innovation and/or product innovation. However, the presence of these attributes cannot be assessed absent specific conversations among customers. Thus, we cannot determine if the firm developed these customer forums with a particular objective in mind, such as web site, service or product innovation. Virtual product tests provide another illustration of the limitations of this measurement approach. We would not expect virtual product tests to be used for web site innovations. Thus, the "web site innovation" attribute is not meaningful for this particular variable.

We recognize that some tools may map onto multiple types of infrastructures, e.g., wikis may be used as both resource infrastructure tool and user infrastructure tool. In mapping tools

to infrastructure type, we took into account prior research and findings from our mini-cases. From a theoretical perspective, Nambisan (2002) conceptually links a range of web-based tools to the three product development roles enacted by customers (resource, cocreator, user). Practitioner-oriented empirical research also maps these tools to infrastructure types (Prandelli et al. 2006). Finally, the results of our mini-cases – specifically the Epsilon case – support our tool-infrastructure mapping.

We adopted a simpler, accepted approach to measuring web-based infrastructure based on Saeed et al. (2005). Let n_1 represent the number of web-based tools (in a particular infrastructure, e.g., resource, cocreation or user) provided by one firm's web site. Different web sites have different n_1. Let N_1 represent the total number of all possible web-based tools in the web-based resource infrastructure. N_1 is the same for all web sites within the sample frame. Therefore, if Firm A has 3 resource tools, then $n_1 = 3$. If $N_1 = 5$, then the index of the web-based resource infrastructure for Firm A is $n_1/ N_1 = 0.6$.

While recent studies provide insight into the online mechanisms available to organizations (cf. Prandelli et al. 2006), rapid changes in online technologies provide the impetus for further work in identifying online mechanisms. Hence, a systematic pretest was conducted to determine appropriate web-based tools for our resource, cocreation and user infrastructure measures. In line with our target sample frame criteria, we conducted our pretest on 25 randomly selected web sites of public U.S.-based firms operating in either the computer manufacturing or prepackaged software industries (see Appendices C and D for more details). Table 4.4 describes existing web-based infrastructure tools based on the results of our pretest and prior research (Prandelli et al. 2006).

Table 4.4. Web-Based Infrastructure Tools

Tool ID	Tool	Illustration	Infrastructure Type
IR1	"Contact the Firm" Option	A "Contact Us" hyperlink or web-based form	Resource
IR2	Feedback Survey	A structured survey in which the company purposefully solicits feedback	Resource
IR3	Chat Rooms	Designated areas where customers can chat about the company's products and/or services	Resource
IR4	Company Chat	Tools that allow customers to chat with company representatives	Resource
IR5	Suggestion Box	A web-based form in which the company solicits suggestions from customers	Resource
IR6	Online Poll	A structured poll in which customers can vote for a particular topic	Resource
IR7	Weblog	A web page maintained by a company representative with regular entries of commentary; customers can usually post comments on these web pages	Resource
IC1	Product Extensions	A set of web pages that provide access to product "add-ons" or extensions	Cocreation
IC2	Aesthetic Design Toolkit	A set of tools that allow customers to manipulate the aesthetic attributes of a product or service	Cocreation
IC3	Functional Design Toolkit	A set of tools that allow customers to manipulate the functional attributes of a product or service	Cocreation
IU1	User Reviews	Web pages that allow users to post product and service reviews	User
IU2	Product Test	Simulation technologies which allow users to test products in a virtual setting; also includes beta releases of products and services	User
IU3	Beta Pages	Web pages that provide early releases of products and/or services	User
IU4	Wiki	A collection of web pages designed to enable users to contribute or modify content	User
IU5	Knowledge Yellow Pages	A directory which allows users to locate and contact subject area experts (who are often customers themselves)	User
IU6	Bulletin Boards	Forums in which users can post and respond to questions and issues	User

4.2.1.5 Analytical Ability

Analytical ability is defined as the extent to which IT applications provide analytical tools to support decision-making in the context of customer interactions. We adopt items for analytical ability from Saeed (2004). These items are provided in Table 4.5.

Table 4.5. Items for Analytical Ability

Item #	Item
AA1	We have IT applications which offer various decision-making tools (such as optimization, scenario analysis, etc.) for managing our relationships with customers.
AA2	We have IT applications which offer various simulation and what-if analysis tools for managing our relationships with customers.
AA3	We have IT applications which offer various tools that enable us to examine trends in the data for supporting our interactions with customers.
AA4	We have IT applications which offer various statistical tools for supporting our interactions with customers.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.*	

4.2.1.6 Interfunctional Coordination

Interfunctional coordination is defined as the degree to which a firm's functions develop a mutual understanding of each other's capabilities and align their respective goals and activities based on such understanding. Table 4.6 provides our items for interfunctional coordination, which are adopted from Atuahene-Gima (2005).

Table 4.6. Items for Interfunctional Coordination

Item #	Item
COI1	The activities of functional units are tightly coordinated to ensure better use of our market knowledge.
COI2	Functions such as R&D, marketing, and manufacturing are tightly integrated in cross-functional teams in product development processes.
COI3	R&D, marketing and other functions regularly share market information about customers, technologies, and competitors.
COI4	There is a high level of cooperation and coordination among functional units in setting the goals and priorities for the organization to ensure effective response to market conditions.
COI5	Top management promotes communication and cooperation among R&D, marketing, and manufacturing in market information acquisition and use.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.*	

4.2.1.7 Channel Coordination

Channel coordination refers to the extent to which the activities of a focal firm are coordinated with its business partners such that the processes spanning firm boundaries are operationally integrated. We adopt channel coordination items from Saraf et al. (2007). These items are detailed in Table 4.7.

Table 4.7. Items for Channel Coordination

Item #	Item
COE1	To facilitate operations, our organization's business procedures and routines are linked with the business procedures and routines of our channel partners.
COE2	Our way of doing business is closely linked with our channel partners.
COE3	The business procedures and routines of our business unit are highly coupled with the business procedures and routines of our channel partners.
COE4	Some of our operations are closely connected with the operations of our channel partners.
COE5	To operate efficiently, we rely on procedures and routines of our channel partners.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: Please indicate how much you agree or disagree with the following statements describing your business unit's ties with its large channel partners (e.g., contract manufacturers, suppliers) only.*	

4.2.1.8 Internal IS Integration

Internal IS integration refers to the degree to which the firm's information systems provide integrated access to data across organizational sub-units. We use items developed by Bharadwaj et al. (2007), which are provided in Table 4.8.

Table 4.8. Items for Internal IS Integration

Item #	Item
INTI1	...all customer-related data (e.g., service contracts, feedback, etc.)
INTI2	...all order-related data (e.g., order status, handling requirements, etc.)
INTI3	...all production-related data (e.g., resource availability, quality, etc.)
INTI4	...all market-related data (e.g., promotion details, future forecasts, etc.)
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response. Our information systems allows us integrated access to...*	

4.2.1.9 External IS Integration

External IS integration refers to the extent to which the IS applications of a focal firm work as a functional whole in conjunction with the IS applications of its business partners. We adopt external IS integration items from Saraf et al. (2007). These items are detailed in Table 4.9.

Table 4.9. Items for External IS Integration

Item #	Item
INTE1	Data are entered only once to be retrieved by most applications of our channel partners.
INTE2	We can easily share our data with our channel partners.
INTE3	We have successfully integrated most of our software applications with the systems of our channel partners.
INTE4	Most of our software applications work seamlessly across our channel partners.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: Please indicate how much you agree or disagree with the following statements describing your business unit's ties with its large channel partners (e.g., contract manufacturers, suppliers, subcontractors) only.*	

4.2.1.10 Control Variables

Research suggests that firm age and firm size should be included as controls for competitive activity (Chen and Hambrick 1995; Miller and Chen 1996; Young et al. 1996). We operationalize firm age as number of years since the firm was founded and firm size as number of employees. Data for firm age and firm size will be collected from the primary respondent.

4.2.2 Measurement Items: Survey Two

We measured competitive activity in our second survey. Competitive activity refers to the set of externally directed, specific and observable newly created moves initiated by a firm to enhance its competitive position (Chen et al. 1992; Young et al. 1996). This definition includes

only actions that had been implemented and were observable to customers, competitors and other industry participants and described in the business press. The underlying assumption is that if an action is reported as news in major media outlets, it represents a significant, newsworthy deviation from the acting firm's normal routines and actions (Ferrier et al. 1999). Based on this assumption, the vast majority of empirical competitive dynamics research is based on secondary data methods and sources (Duriau et al. 2007; Smith et al. 2001).

However, a secondary data approach to measuring competitive activity is limited for our study for a number of reasons. First, respondents may not provide company information, which would inhibit us from matching their survey responses to competitive activity in secondary sources. Second, determining whether or not a competitive action was taken based on customer input, feedback or suggestions using secondary data would be highly subjective, if not impossible. As a result of these limitations, we used a second survey to measure competitive activity.

Following prior work, we categorize actions into five categories: pricing actions, marketing actions, product/service announcements, capacity/distribution actions, and alliance actions (Basdeo et al. 2006; Ferrier et al. 1999). Table 4.10 contains the description, key words and sample headlines for each action category.

Table 4.10. Definitions and Examples of Action Categories

Action Category	Measure	Examples of Headlines
New pricing action	Count of headlines containing one of these words: price, rate, discount, rebate	To counter Microsoft, IBM offers discounts and training to colleges
New marketing action	Count of headlines containing one of these words: ads, spot, promote, distribute, campaign	Home Depot to kick off new TV ads
New product action	Count of headlines containing one of these words: introduce, launch, unveil, roll out (product or service)	Toyota will launch Prius station wagon
New capacity action	Count of headlines containing one of these words: raises, boosts, increases (capacity or output)	Intel to raise chip output
New alliance action	Count of headlines containing one of these words: joint venture, alliance, vertical customer agreement, distribution agreement	IBM forges alliance with Apple

As noted in Chapter 3, we measure four types of competitive activity: action volume, action repertoire complexity, customer response quality, and customer response speed.

4.2.2.1 Action Volume

Action volume is calculated as the total number of a firm's actions in a given year. Table 4.11 details our items for action volume.

Table 4.11. Items for Competitive Action Volume

Item #	Item
ACT1	New pricing actions (e.g., major price increases, discounts, rebates)
ACT2	New marketing actions (e.g., rewards, promotions, marketing campaigns)
ACT3	New product actions (e.g., new product/service launch, roll out, release)
ACT4	New capacity actions (e.g., changes in capacity or output of products or services)
ACT5	New alliance actions (e.g., new joint venture, alliance, distribution agreement)
Scale Range: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, >10 *Stem: Please indicate the number of major actions your company executed in the following categories. Based on customer feedback, input or suggestions, we executed…*	

4.2.2.2 Action Repertoire Complexity

Action repertoire complexity is defined as the extent to which a firm concentrates on carrying out a broad range of action types in a given time period (Miller and Chen 1996). Following extant research on competitive dynamics (Basdeo et al. 2006; Ferrier et al. 1999; Miller and Chen 1996), action repertoire complexity is operationalized using a Herfindahl action concentration index, calculated as follows:

$$1 - \sum(N_a/NT)^2$$

where N_a/NT is the share or proportion of market actions in the *a*th action category. A higher score on this measure indicates greater complexity in an action repertoire. We used the indicators for competitive action volume (see Table 4.10) to calculate action repertoire complexity.

4.2.2.3 Customer Response Quality

We developed new measures for customer response quality. Customer response quality refers to the extent to which a firm executes actions which meet customer needs in a given timer period. This measure was based on the extant literature and subjected to a rigorous instrument development process per recommended guidelines (Churchill 1979). Details of our development and validation of this measure are presented in Chapter 5. Table 4.12 includes our measures for customer response quality.

Table 4.12. Items for Customer Response Quality

Item #	Item
CRQ1	Percentage of pricing actions which met customer needs
CRQ2	Percentage of marketing actions which met customer needs
CRQ3	Percentage of product actions which met customer needs
CRQ4	Percentage of capacity actions which met customer needs
CRQ5	Percentage of alliance actions which met customer needs
Scale Range: < 10; 10-19; 20-29; 30-39; 40-49; 50-59; 60-69; 70-79; 80-89; 90-100 (percentages) *Stem: Please estimate what percentage of major actions your organization took in 2008 that, based on your organization's assessment, met or addressed customer needs.*	

4.2.2.4 Customer Response Speed

We also developed new measures for customer response speed. Customer response speed is defined as the rate at which a firm responds to customer-based opportunities for innovation and competitive action. Details of our development and validation of this measure are presented in Chapter 5. Table 4.13 details our measures for customer response speed.

Table 4.13. Items for Customer Response Speed

Item #	Item
CRS1	We took quick action when something important happened with regard to our customers.
CRS2	We quickly implemented our planned activities with regard to customers.
CRS3	When we identified a new customer need, we were swift to execute the appropriate action.
CRS4	We were fast to take action in response to changes in our customers' product or service needs.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: Keep in mind the major actions your organization took in 2008 in response to customer feedback, input or suggestions. For each of the statements below, please indicate how much you agree or disagree with each by selecting the appropriate response.*	

In addition to using structured items, we will also ask the respondent a few open-ended questions to gain a better understanding of how the organization responds to customer-based opportunities for innovation and competitive action. Such qualitative data is especially important in initial research in a particular area of inquiry, such as the area surrounding IT, customer agility and competitive activity. Table 4.14 details our open-ended items.

Table 4.14. Open-Ended Items

Item #	Item
OP1	Please briefly describe this action:
OP2	Please briefly describe the basis or criterion on which you decided to execute this action:
OP3	Please briefly describe what your business unit had to do to successfully implement this action:
OP4	Please briefly describe how you evaluated whether this action was successful:
OP5	If applicable, please briefly describe how your organization used information technology during this process (e.g., we collected customer data through our web site, we used software to analyze customer data):
Stem: Among the actions your business unit took in 2008, think of ONE in particular that stood out as being the most successful.	

4.2.3 Measurement Approach

When using structural equation modeling techniques, it is important to conceptualize the underlying structure of the constructs before proceeding to their measurement (Petter et al. 2007). In particular, we need to understand the nature and direction of relationships between the constructs and their indicators. Indicators can be either reflective or formative (Edwards and Bagozzi 2000). Reflective indicators represent reflections, or manifestations, of a construct. In a reflective measurement approach, constructs are viewed as causes of indicators, meaning that variation in a construct leads to variation in its indicators (Bollen 1989). In some instances, the direction of the relationship between constructs and indicators is reversed, such that indicators

are treated as causes of constructs (MacCallum and Browne 1993). Formative indicators form or produce their associated construct (Fornell and Bookstein 1982). For example, a formative construct could be firm performance operationalized using three indicators: productivity, profitability and market share. Each indicator captures differing aspects of firm performance; as a result, this operationalization of the construct is formative.

Jarvis et al. (2003) provide the following guidelines on whether to model a construct as formative or reflective: (1) direction of causality from construct to indicators, (2) interchangeability of indicators, (3) covariation among indicators, and (4) nomological net of construct indicators. Constructs should be modeled as formative if the following decision rules hold: the direction of causality is from indicators to constructs, the indicators need not be interchangeable, covariation among indicators is not necessary, and the nomological net of indicators can differ, i.e., they may have different antecedents and consequences. Constructs should be modeled as reflective if the opposite conditions apply. Specifically, constructs should be modeled as formative if the answer to all of the following statements is “yes”:

- Indicators are defining characteristics of the construct.
- Changes in indicators should cause changes in the construct.
- Changes in the construct do not cause changes in the indicators.
- Indicators do not necessarily share a common theme.
- Eliminating an indicator may alter the conceptual domain of the construct.

- A change in the value of one of the indicators is not necessarily associated with a change in all of the other indicators.

- Indicators are not required to have the same antecedents and consequences.

Table 4.15 provides the answers to these statements for each construct in the model. These answers are based on our judgment, assessment of the conceptual structure of the construct, investigation of the causal relationship between the indicators and the construct, and analysis of previous studies that have measured similar constructs. Please note that we do not include web-based infrastructure, action volume, action repertoire complexity, and customer response quality measures because they consist of single items.

Table 4.15. Analysis Approach for Multi-Item Latent Variables

Construct	Are the indicators defining characteristics of the construct?	Do changes in indicators cause changes in the construct?	Do changes in the construct cause changes in the indicators?	Do the indicators necessarily share a common theme?	Does eliminating an indicator alter the conceptual domain of the construct?	Is a change in one of the indicators necessarily associated with a change in all of the other indicators?	Do the indicators have the same antecedents and consequences?	Scale Type
Customer Sensing Capability	No	No	Yes	Yes	No	Yes	No	Reflective
Customer Responding Capability	No	No	Yes	Yes	No	Yes	No	Reflective
Analytical Ability	No	No	Yes	Yes	No	Yes	No	Reflective
Interfunctional Coordination	No	No	Yes	Yes	No	Yes	No	Reflective
Channel Coordination	No	No	Yes	Yes	No	Yes	No	Reflective
Internal IS Integration	No	No	Yes	Yes	No	Yes	No	Reflective
External IS Integration	No	No	Yes	Yes	No	Yes	No	Reflective
Customer Response Speed	No	No	Yes	Yes	No	Yes	No	Reflective

4.3 Analysis Plan

Figure 4.3 details our plan for how the analysis of the research model will be conducted. There are three phases: preparation, measurement validation and structural validation. In the following sections we describe these phases in greater detail.

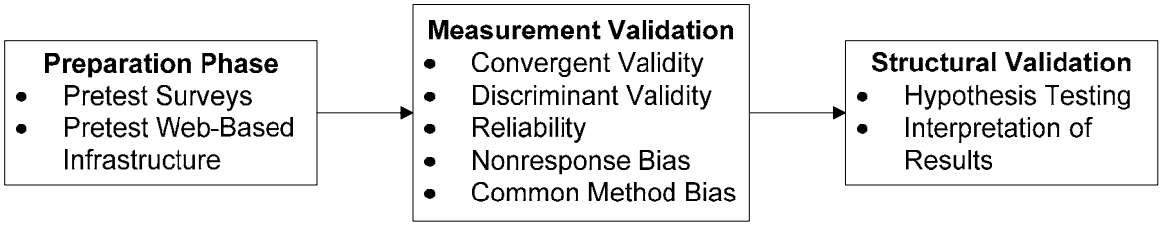


Figure 4.3. Analysis Plan

4.3.1 Preparation Phase

The preparation phase includes all analyses prior to the main data collection period. One goal of the preparation phase is to avoid costly mistakes. A pretest was conducted for both survey instruments. Feedback on wording and clarity of the survey instrument was provided by practitioners, faculty members and PhD students. The participants had little difficulty interpreting the survey instructions and questions. Minor improvements were made to the survey instrument based on participants' feedback. Development of the surveys is described in greater detail in Chapter 5. A systematic pretest was also conducted to determine appropriate web-based tools for our resource, cocreation and user infrastructure measures. The results were described earlier.

4.3.2 Measurement Validation

The next phase validates the measurement model. Assessments of the data will be made for possible outliers and non-normal distribution. All indicators will be mean-centered per recommended guidelines (Aiken and West 1991; Cohen et al. 2003).

Constructs will be assessed in terms of convergent validity, discriminant validity and reliability. It is important to note that most of the constructs in our research model are measured by multiple items. Hence, we will use structural equation modeling techniques to assess measurement properties of multi-item measures. Tools employed to test construct validity and reliability include confirmatory factor analysis, e.g., assessing factor loadings, model fit, pairwise comparison between constructs, and Cronbach's alpha, respectively.

It is important to note that one of our endogenous variables – action volume – consists of count data. Thus, we will transform this data so that this measure can be included in our analyses. We will also assess non-response bias and common method bias, analyses which are detailed in the following sections.

4.3.2.1 Non-response Bias

Because the value of survey-based research is dependent on individuals participating in the research initiative, low response rates are a perpetual concern among researchers and others who conduct, analyze, interpret, and act on survey results. In addition to causing smaller data samples, low response rates can undermine the actual generalizability of the collected data because of non-response bias (Rogelberg and Stanton 2007). When the sample frame is well-defined, non-response bias can produce misleading conclusions that do not generalize to the entire population (Rogelberg and Luong 1998).

Non-response bias is usually operationalized with the following heuristic formula: non-response bias = P_{NR} ($X_{res} – X_{Pop}$), where P_{NR} refers to the proportion of non-respondents, X_{Res} is the respondent mean on a survey variable, and X_{Pop} is the population mean on the corresponding survey variable (if it were actually known) (Rogelberg and Luong 1998). With this formula in mind, the possible range of bias depends on the response rate – which bounds the extent to which the sample may be biased – and the distinctiveness of non-respondents. The following scenarios adapted from Fowler illustrate this point.

> Suppose a population of 1000 is surveyed, and 900 respond (response rate of 90%). Of those 900, 450 say yes to some question; the other 450 say no. There are 100 people (the nonrespondents) whose views we do not know. If these nonrespondents would have responded with a yes, the true figure for the population would be 55% yes. If they would have responded with a no, the true population rate would be 45% yes. Regardless of the 90% response rate, the range is quite large, and it spans a region where either yes or no could have been the majority vote.
>
> Suppose a population of 1000 is surveyed, and 100 respond (response rate of 10%). Of those 100, half say yes to some question; the other half say no. There are 900 people (the nonrespondents) whose views we do not know. If half of these nonrespondents had responded with a yes, the true figure for the population would be 50% yes—identical to what the sample results showed.

Examining the heuristic formula and acute scenarios above, we see that response rate alone is an inaccurate and inconsistent proxy for study quality. As a result, researchers should conduct a non-response bias impact assessment, regardless of how high a response rate is achieved (Rogelberg and Stanton 2007). This study will employ wave analysis to assess the potential impact of non-response bias. Wave analysis treats late respondents as a proxy for non-respondents (Armstrong and Overton 1977). We will use wave analysis to compare initial

respondents with those who respond during later stages of the data collection period to assess non-response bias. We will also compare survey two respondents to non-respondents, where the latter group constitutes individuals who responded to survey one, yet did not respond to survey two.

4.3.2.2 Common Method Bias

Common method bias refers to the variance that is attributable to the measurement method rather than to the constructs of interest (Bagozzi and Yi 1991). Researchers have long been interested in the potential impact of common method bias on the validity of research results (Bagozzi et al. 1991; Campbell and Fiske 1959; Campbell and O'Connell 1982; Malhotra et al. 2006; Straub et al. 2004; Williams and Brown 1994). Common method bias is a problem because it is one of several sources of measurement error. Podsakoff et al. (2003) provide an excellent articulation of the potential influence of common method bias on empirical results:

> Let's assume that a researcher is interested in studying a hypothesized relationship between Constructs A and B. Based on theoretical considerations, one would expect that the measures of Construct A would be correlated with measures of Construct B. However, if the measures of Construct A and the measures of Construct B also share common methods, those methods may exert a systematic effect on the observed correlation between the measures. Thus, at least partially, common method biases pose a rival explanation for the correlation observed between the measures (p. 879).

This study will strive to reduce common method bias by implementing several recommendations set forth by Podsakoff et al. (2003). First, where possible we will use multiple methods to measure certain variables. For instance, web-based infrastructure will be assessed using primary and secondary data.

When it is not possible to use multiple methods (e.g., interfunctional coordination and customer responding capability), we hope to reduce common method bias by creating a psychological separation by providing a cover story to make it appear that the measurement of the predictor variable is not related to the measurement of the criterion variable. Psychological separation between variables diminishes bias by reducing the perceived relevance of the previously recalled information in short-term memory (Podsakoff et al. 2003). Biases can also be reduced by assuring respondents anonymity and informing respondents that there are no right or wrong answers. This procedure should reduce any apprehension on respondents' part of being evaluated, socially desirable or consistent with how they think the researcher wants them to respond.

We will also use a short-form measure of social desirability bias (cf. Table 4.16, Reynolds 1982) to assess the effect that a respondent may be answering questions based on social norms (Crowne and Marlowe 1964). We will compare two models to assess the potential effect of common method bias. Model A will contain items loading on to their respective latent factors, and Model B will contain all the items loading on to their respective latent factors and on to the first-order social desirability factor. Following this, we will compare the fit indices between Model A and Model B. Researchers recommend that a change in Comparative Fit Index (CFI) less than 0.01 indicates no significant difference between two models (Cheung and Rensvold 2002).

Table 4.16. Items for Social Desirability Bias

Item #	Item
SDB1	It is sometimes hard for me to go on with my work if I am not encouraged.
SDB2	I sometimes feel resentful when I don't get my way.
SDB3	On a few occasions, I have given up doing something because I thought too little of my ability.
SDB4	There have been times when I felt like rebelling against people in authority even though I knew they were right.
SDB5	I am sometimes irritated by people who ask favors of me.
Scale Range: 1 = Strongly Disagree; 4 = Neutral; 7 = Strongly Agree *Stem: For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.*	

In addition to these aforementioned procedural remedies, we will also employ statistical remedies to reduce any potential common method bias. Specifically, we will use a Harman one-factor test (Harman 1976) and include an unmeasured latent method factor. When using the latter approach, two models are compared to assess the potential effect of common method bias. Model A contains items loading on to their respective latent factors, and Model B contains all the items loading on to their respective latent factors and on to a first-order common method factor. Modeling a latent method factor significantly improves the fit of the model if common method bias accounts for most of the covariance observed in the variables. One of the main advantages of the unmeasured latent method factor technique is that it does not require the researcher to identify and measure the specific factor responsible for the method effects (Podsakoff et al. 2003). In addition, this technique models the effect of the method factor on the measures rather than on the latent variables they represent and does not require the effects of the method factor on each measure to be equal.

4.3.3 Structural Validation

The proposed hypotheses are tested in the structural validation phase. Since our research model and associated measures require a variety of analytic techniques, we will use linear regression, structural equation modeling, and polynomial regression techniques to test the research model. We will also follow prescribed guidelines for testing moderation effects (Aiken and West 1991; Carte and Russell 2003; Marsh et al. 2004). Finally, all results will be interpreted appropriately.

4.4 Chapter Summary

In this chapter we described methods used to test the validity of our research model. We described how the results of our three mini-cases informed our research model and research design. Following this we discussed the research design in particular. Our including unit of analysis is a business unit, and the key informant is a marketing manager. Our target sample frame consists of firms competing in high tech industries, e.g., computer manufacturing, software development. These firms require high levels of customer agility, possess a diverse set of web-enabled tools with which their customers can interact, and compete in dynamic environments. Our desired sample size is 230, a conservative estimate, with a minimum target of 180. Finally, we will employ Zoomerang to assist with survey administration.

We also described measures for the constructs in our research model. Our study employs a longitudinal research design, so we will conduct two surveys with the same respondent. We will capture most of the measures in our research model in the first survey, and we will measure each firm's level of competitive activity in the second survey. Since we will use

structural equation modeling techniques, we conceptualized the nature and direction of relationships between the constructs and their indicators.

Finally, we explained our plan for data analysis. The preparation phase includes pretests of our two surveys and our web-based infrastructure measures. We discussed our approach to measurement validation, including construct validity, non-response bias, and common method bias. We concluded by describing how the proposed hypotheses will be tested in the structural validation phase. In the next chapter we describe the results of our data analyses.

CHAPTER FIVE: RESULTS

5.0 Introduction

This chapter describes the results of our data analyses. First we discuss the development of survey one and survey two, followed by a description of our sample. Then we assess potential problems due to non-response bias and common method bias. This is followed by an assessment of our constructs' measurement properties, e.g., construct validity, reliability, descriptive statistics. The next section assesses the structural model and tests our research hypotheses. Finally, we present the results of our qualitative analyses.

5.1 Survey Development

In the following sections we describe the development of both surveys. Specifically, we conducted a pretest and pilot for each survey.

5.1.1 Development of Survey One

We conducted a pretest and pilot to assess the quality of survey one prior to administering the survey to our target sample frame. Pretesting includes carefully examining the content of the survey. Our pilot test allowed us to conduct preliminary analysis on representative pilot data. We describe the pretest and pilot process and results in the following sections.

5.1.1.1 Survey One Pretest

Since all of the scales for survey one were adapted from the literature to the current study, we gave careful consideration to the content validity of the measures. Three faculty members and eight doctoral students carefully assessed the wording of the items in the

questionnaire. Based on their feedback, minor changes were made to the wording and design of the questionnaire. Next, phone interviews were conducted with the three full-time working individuals who participated in the mini-cases (see Chapter 4). The questionnaire was sent to these individuals a few days prior to the interview. Interviews lasted an average of 20 minutes each. The feedback gained from these interviews was incorporated into the questionnaire.

5.1.1.2 Survey One Pilot

We downloaded a mailing list of 1,080 respondents from the Million Dollar Database, a directory of U.S. companies from all industries with sales of one million dollars or more, or 20+ employees, or branches with 50+ employees. These respondents held job titles consistent with our established criteria, such as “Marketing Director”, “Marketing Manager”, “VP Marketing”, and “VP Sales & Marketing”. Consistent with our target sample frame, we restricted our search to public U.S.-based firms operating in high tech industries – specifically the computer manufacturing and prepackaged software (Standard Industrial Classification Industry Groups 3571 and 7372, respectively).

Four-hundred respondents were randomly selected from the initial set of 1,080. Surveys were mailed to these 400 respondents in August 2008. Within four weeks, five surveys were returned as non-deliverable, and eighteen completed surveys were returned (an effective 4.6% response rate). All 18 respondents fully completed their surveys (i.e., there was no missing data). The average respondent age was 47 years, and 61% of the respondents were male. Ninety-five percent of the respondents had at least a bachelors degree. Finally, respondents had an average of 18 years of customer relationship management experience, and an average of 10 years employment with their current organization.

Measures for all of the constructs in the research model were collected. An exploratory factor analysis (EFA) was conducted for each set of items. Most of our measures exhibited clean factor loadings and sufficient reliability (Cronbach's $\alpha > .70$); however, EFA results suggested that some items did not load well with others for the customer sensing capability and customer responding capability constructs. As a result, changes were made to the wording of some items. Table 5.1 describes these changes.

Table 5.1. Changes in Measurement Items

Item #	Original Item	Revised Item
CS1	We continuously try to discover additional needs of our customers of which they are unaware.	We continuously try to discover additional needs of our customers even before they are aware of them.
CS4	We continuously try to anticipate our customers' needs even before they are aware of them.	We continuously try to anticipate our customers' needs.
CS6	We sense our customers' needs even before they are aware of them.	We sense our customers' needs even before they may be aware of them.
CR4	When we find that customers would like us to modify a product or service, our organization makes concerted efforts to do so.	When we find that customers would like us to modify a product or service, our organization rapidly makes concerted efforts to do so.

Our pilot analysis placed sufficient confidence in the scales to proceed with the full-scale survey administration of the target sample frame. Appendix A contains the complete survey one. In the next section, we describe our development of survey two.

5.1.2 Development of Survey Two

The second survey for our study attempts to capture the quantity and quality of competitive activity undertaken by firms in a specific time period. Competitive dynamics researchers' heavy reliance on secondary data (Duriau et al. 2007) has precluded them from

capturing certain measures of competitive activity, such as competitive action efficacy and quality. In an effort to move beyond quantity-based approaches to competitive activity, we conceptualize and develop two salient activity-based outcomes of customer agility: customer response quality and customer response speed. Customer response quality is defined as the extent to which a firm executes actions which meet customer needs in a given time period. Customer response speed is defined as the speed at which a firm responds to customer-based opportunities for innovation and competitive action. We conducted a pretest and pilot to assess the quality of survey two prior to administering the survey to our target sample frame.

5.1.2.1 Survey Two Pretest

Measurement items for customer response quality and customer response speed were developed by the primary researcher. Three faculty members and five doctoral students carefully assessed the wording of these items. Based on their feedback, minor changes were made to the wording and design of the questionnaire. Next, phone interviews were conducted with the two full-time working respondents who participated in the mini-cases (see Chapter 4). The questionnaire was sent to these individuals a few days prior to the interview. Interviews lasted an average of 10 minutes each. The feedback gained from these interviews was incorporated into the questionnaire.

5.1.2.2 Survey Two Pilot

We administered survey two to a group of Evening MBA students. Eighteen full-time working MBA students completed the questionnaire and provided feedback on wording and clarity of the instrument. The feedback gained from this process was incorporated into the instrument. We also added an “economic impact” control variable to the questionnaire. The

"economic impact" variable (5 items) assesses the extent to which recent economic conditions impacted the respondent's organization. Our pilot analysis placed sufficient confidence in the scales to proceed with the full-scale survey administration of the target sample frame. Appendix B contains the complete survey two. In the next section, we present the results of our data analyses.

5.2 Sample Characteristics

As noted in Chapter 4, the sample for this study was obtained through Zoomerang. Zoomerang generated a random set of 1,200 sales/marketing managers employed in high tech firms, who were then invited to complete the web-based survey. Of these 1,200, a total of 345 individuals accessed the survey hosted on Zoomerang's web site. To ensure the validity of our target sample frame, we developed the following screening question: "Which of the following organizational functions are you assigned to?" Of these 345 individuals, only 208 answered "Marketing" or "Sales". The remaining 137 individuals were not allowed to continue with the survey, leaving us with 208 initial respondents.

There were 78 missing values in the data set containing our principal constructs (i.e., customer agility, IT constructs, organizational factors; this does not include demographics), which is less than 0.01% of the total number of values. We performed Little's MCAR test (Little and Rubin 1987) and found that these values were missing completely at random ($p > 0.05$). So long as data are not missing completely at random (missing values on variable X are related to missing values on variable X), the data may be imputed without violating the assumption of MCAR (Allison 2003). We implemented direct maximum likelihood (ML) imputation methods in EQS (Byrne 2006). Direct ML imputation methods have been found to be more favorable and

robust than traditional methods of handling missing data, such as listwise or pairwise deletion (Allison 2003). These ML imputation methods have been used in prior IS research (Saraf et al. 2007).

Findings from our mini-cases and a survey of industry data show that many high tech firms – particularly online research firms that specialize in information products – often employ relatively small numbers of employees. For instance, the respondent in the Omicron case remarked that a notable proportion of Omicron's competitors employ no more than 8-10 people. Based on this information, we excluded very small organizations with number of employees less than 5 from our sample. Finally, we employed regression diagnostics (e.g., leverage statistics, Mahalanobis distance) to screen for statistical outliers. We were left with an effective sample size of 188. Although this does not meet our desired sample size of 230, it does meet the lower threshold of 180 derived from our power analysis in Chapter 4.

Table 5.2 details demographic characteristics of the sample. The demographics of our sample reveal that most were female (60%), middle-age (mean = 45 years), and well-educated (95% with at least some college experience). Respondents' average organizational tenure was 8.3 years, with an average of 5.1 years in their current position. They were highly active in formulation of marketing/sales policies for their firms at the time of the study (mean = 4.29 on a 5-point scale, 5 representing "very active"). Thus, respondents were highly qualified to answer the questions. The median firm size was 400 employees, and the average firm age was 36.5 years.

Table 5.2. Demographics

Category	Characteristics
Gender	Male 40% Female 60%
Age	Mean 45 years
Education	High School 5% Some College 12% College Degree 47% Graduate Degree 36%
Years employed with organization	Mean 8.3 years
Years spent in current position	Mean 5.1 years
Firm size	Median 400 employees
Firm age	Mean 36.5 years

Our second survey was also deployed through Zoomerang. Zoomerang invited the initial 208 survey one respondents to complete the second web-based survey. Of these 208, a total of 112 individuals completed the second survey for an effective response rate of 54%. We used two mechanisms to ensure that the same individual responded to both surveys for a single organization. First, Zoomerang provided unique identification numbers for each individual, thus allowing us to match the two data sets. Second, we asked the question, "How old were you on your last birthday?" on both surveys. We calculated the difference in respondent age between the two data sets. The difference score for all 112 respondents was zero or one (one signifying that the respondent had a birthday between the time he/she completed survey one and the time he/she completed survey two). This provides further support that the same individual responded to both surveys.

Our screens for statistical outliers, very small organizations and missing data resulted in an effective sample size of 108.

5.3 Analysis of Non-Respondent Bias

We assessed the potential impact of non-respondent bias for survey one and survey two. This assessment is described in the following sections.

5.3.1 Non-Response Bias: Survey One

We employed wave analysis to assess potential non-respondent bias in survey one. Wave analysis treats late respondents as a proxy for non-respondents (Armstrong and Overton 1977). Responding firms were grouped into early and late respondents, and comparisons were made along firm size and firm age. Firm size is measured by the logarithm of the number of employees. Firm age is measured by the number of years the firm has existed. The middle point of the data collection time frame was used as the cutoff point for distinguishing between early and late respondents. As Table 5.3 indicates, there are no significant differences between early respondents and late respondents. Based on these findings, response bias did not pose a substantial threat to this study.

Table 5.3. Assessment of Non-Response Bias: Survey One

	N	Mean	S.D.	F-value	d.f.	Sig.
Firm Size				0.079	180	0.780
Early Respondents	89	2.68	1.11			
Late Respondents	92	2.73	1.24			
Firm Age				0.014	156	0.905
Early Respondents	80	49.43	44.49			
Late Respondents	77	50.27	44.53			

5.3.2 Non-Response Bias: Survey Two

Responding and non-responding firms were compared along firm size and firm age for the second survey. As Table 5.4 indicates, there are no significant differences between

responding and non-responding firms. Based on these findings, non-response bias can be ruled out in this study.

Table 5.4. Assessment of Non-Response Bias: Survey Two

	N	Mean	S.D.	F-value	d.f.	Sig.
Firm Size				0.219	206	0.640
Non-Respondents	105	2.45	1.36			
Respondents	102	2.36	1.39			
Firm Age				0.150	184	0.699
Non-Respondents	91	47.29	46.43			
Respondents	94	44.73	43.12			

5.4 Measurement Properties of Constructs

The overall research model cannot be tested unless measurement properties of the constructs are found to be reliable and valid. The following components of construct validity are assessed: content validity, convergent validity, and discriminant validity. Measurement properties of the constructs are assessed in two stages. In the first stage, items of the hypothesized constructs are subjected to a purification process in order to identify a set of items that sufficiently captures the variance in the data. Conceptual and empirical criteria are used to guide the item purification process (Churchill 1979). Conceptual criteria include theoretical content covered by the items, consistency of content, and clarity of conceptual meaning of the items. Empirical criteria include Cronbach's alphas, factor loadings, and model fit statistics. In the second stage, convergent and discriminant validity of the constructs are assessed. We used confirmatory factor analysis techniques in EQS 6.1 to evaluate measurement properties of the constructs. In the following section we discuss assumptions underlying the use of structural equation modeling techniques.

5.4.1 Structural Equation Modeling Assumptions

Use of structural equation modeling requires that certain assumptions are met or suitable adjustments are made for assumptions that cannot be reasonably met. These assumptions are that the data be ratio/interval, variables assume a minimum of four values, data is multivariate normal, the model is over identified (the model has more information than there are unknown parameters), and there is sufficient sample size.

Our measurement items for three constructs – resource infrastructure, cocreation infrastructure, and user infrastructure – are all categorical variables with two categories each (dichotomous variables with either a 0 or 1 value). Applications involving the use of categorical data are based on three important assumptions: (1) underlying each categorical observed variable is an unobserved latent counterpart, the scale of which is both continuous and normally distributed; (2) sample size is sufficiently large to enable reliable estimation of the related correlation matrix; and (3) the number of observed variables is kept to a minimum (Byrne 2006). These strict assumptions formulating the analysis of categorical data poses difficult challenges for researchers working with categorical data. Although EQS provides a methodology to solve these dilemmas, scholars suggest that since there is no way as yet to evaluate whether the assumptions underlying the methodology are reasonable, researchers should avoid using this methodology when possible (Bentler 2005; Byrne 2006). Since we created composite index values for each web-based infrastructure construct, we do not use EQS to assess models that include web-based infrastructure.

With respect to multivariate normality, we examined Mardia's (1970) normalized estimate to determine the extent to which our data are normally distributed. Mardia's

normalized estimate assesses the degree of kurtosis in the data. When the sample is very large and multivariately normal, Mardia's normalized estimate is distributed as a unit normal variate such that large values reflect significant positive kurtosis and large negative values reflect significant negative kurtosis (Byrne 2006). Bentler (2005) suggests that values greater than 5.00 are indicative of data that are non-normally distributed. When evidence suggested that data are not normally distributed, we used the Satorra-Bentler scaled χ^2 statistic (Satorra and Bentler 1988) and corresponding robust fit estimates provided by EQS 6.1 (Byrne 2006). Computation of the Satorra-Bentler χ^2 statistic takes into account the model, the estimation method, and the sample kurtosis values. The Satorra-Bentler χ^2 statistic has been shown to be the most reliable test statistic for evaluating mean and covariance structure models under various distributions and sample sizes (Curran et al. 1996; Hu et al. 1992). When the ROBUST option is invoked, EQS automatically computes robust standard errors (Bentler 2005). Additionally, robust versions of the CFI, RMSEA, and the 90% confidence interval related to the RMSEA are also reported. That these statistics are "robust" means that their computed values are valid, despite violation of the normality assumption underlying the estimation method (Byrne 2006). These robust fit estimates have been used in prior IS research (Swanson and Dans 2000).

Finally, all of our structural models were over-identified with positive degrees of freedom. We also met an adequate sample size based on the estimate calculated in Chapter 4.

5.4.2 Convergent Validity

Convergent validity assesses the extent to which different indicators for the measure refer to the same conceptual construct. For each construct, the refinement of the scale followed an iterative procedure, where only one item was changed at every step (Joreskog 1993).

Modifications were based on factor loadings and modification indices and were performed only when theoretically justified. Standardized factor loadings were expected to meet the minimum recommended value of 0.70, which indicates that the indicator reliability is over 0.50 (Hair et al. 1998). We modified the model until all parameter estimates and overall fit measures for each construct were considered satisfactory (4 of 38 items were dropped; cf. Table 5.5). The final measurement model consisted of all the items loading on their respective factors. All of the constructs were freely correlated. The fit indices suggest that the data fits the model well (Satorra-Bentler χ^2 = 489.29, d.f. = 384; CFI = 0.96; RMSEA = 0.038).

Table 5.5 Factor Loadings

Item #	Item	Factor Loading
Customer Sensing Capability		
CS1	We continuously try to discover additional needs of our customers of which they are unaware.	0.70
CS2	We work closely with lead users who try to recognize customer needs months or even years before the majority of the market may recognize them.*	0.56
CS3	We extrapolate key trends to gain insight into what users in a current market will need in the future.	0.71
CS4	We continuously try to anticipate our customers' needs even before they are aware of them.	0.82
CS5	We attempt to develop new ways of looking at customers and their needs.	0.83
CS6	We sense our customers' needs even before they are aware of them.	0.77
Customer Responding Capability		
CR1	We respond rapidly if something important happens with regard to our customers.	0.75
CR2	We quickly implement our planned activities with regard to customers.	0.85
CR3	We quickly react to fundamental changes with regard to our customers.	0.85
CR4	When we find that customers would like us to modify a product or service, our organization makes concerted efforts to do so.*	0.62
CR5	When we identify a new customer need, we are quick to respond to it.	0.83

Item #	Item	Factor Loading
CR6	We are fast to respond to changes in our customers' product or service needs.	0.90
Analytical Ability		
AA1	We have IT applications which offer various decision-making tools (such as optimization, scenario analysis, etc.) for managing our relationships with customers.	0.86
AA2	We have IT applications which offer various simulation and what-if analysis tools for managing our relationships with customers.	0.87
AA3	We have IT applications which offer various tools that enable us to examine trends in the data for supporting our interactions with customers.	0.73
AA4	We have IT applications which offer various statistical tools for supporting our interactions with customers.*	0.61
Interfunctional Coordination		
COI1	The activities of functional units are tightly coordinated to ensure better use of our market knowledge.	0.74
COI2	Functions such as R&D, marketing, and manufacturing are tightly integrated in cross-functional teams in product development processes.	0.79
COI3	R&D, marketing and other functions regularly share market information about customers, technologies, and competitors.	0.75
COI4	There is a high level of cooperation and coordination among functional units in setting the goals and priorities for the organization to ensure effective response to market conditions.	0.86
COI5	Top management promotes communication and cooperation among R&D, marketing, and manufacturing in market information acquisition and use.	0.80
Channel Coordination		
COE1	To facilitate operations, our organization's business procedures and routines are linked with the business procedures and routines of our channel partners.	0.74
COE2	Our way of doing business is closely linked with our channel partners.	0.88
COE3	The business procedures and routines of our business unit are highly coupled with the business procedures and routines of our channel partners.	0.89
COE4	Some of our operations are closely connected with the operations of our channel partners.	0.80
COE5	To operate efficiently, we rely on procedures and routines of our channel partners.*	0.60
Internal IS Integration		
INTI1	...all customer-related data (e.g., service contracts, feedback, etc.)	0.79

Item #	Item	Factor Loading
INTI2	...all order-related data (e.g., order status, handling requirements, etc.)	0.75
INTI3	...all production-related data (e.g., resource availability, quality, etc.)	0.81
INTI4	...all market-related data (e.g., promotion details, future forecasts, etc.)	0.82
External IS Integration		
INTE1	Data are entered only once to be retrieved by most applications of our channel partners.	0.70
INTE2	We can easily share our data with our channel partners.	0.86
INTE3	We have successfully integrated most of our software applications with the systems of our channel partners.	0.86
INTE4	Most of our software applications work seamlessly across our channel partners.	0.84
Customer Response Speed		
CRS1	We took quick action when something important happened with regard to our customers.	0.71
CRS2	We quickly implemented our planned activities with regard to customers.	0.76
CRS3	When we identified a new customer need, we were swift to execute the appropriate action.	0.96
CRS4	We were fast to take action in response to changes in our customers' product or service needs.	0.82
* These items were dropped from further analysis.		

We collected 64 valid web site addresses from our respondents. We visited these web sites and coded values for the 16 indicators of our 3 web-based infrastructure constructs. Inter-rater reliabilities were calculated for each of the indicators using Cohen's (1960) kappa. Cohen's kappa adjusts the raw agreement to account for the possibility of agreement occurring by chance. Kappa values ranged from 0.76 to 0.80. The levels of agreement across all 16 indicators are highly significant. Kappa values between 0.61 and 0.80 are regarded as "substantial," whereas those equal to or greater than 0.81 are considered "almost perfect" (Landis and Koch 1977). Our results show that the agreement reliability between the respondents and the author

for indicators of web-based infrastructure was on the high side of "substantial." These results provide further support for the validity of our web-based infrastructure measures.

5.4.3 Discriminant Validity

Discriminant validity refers to the extent to which the measures for each construct are distinctively different from each other. We used a chi-square difference test to evaluate discriminant validity (Venkatraman 1989a). For each pair of constructs, the fit of the previously identified model was compared with the fit of a model where the two constructs are said not to be distinct. Constraining the correlation between the pairs of constructs to unity suggests that all the items measure the same construct. A significant chi-square difference between the χ^2 supports discriminant validity.

Table 5.6 reports the results of 28 pairwise tests. All chi-square differences are significant at the $p < 0.05$ level, indicating support for discriminant validity. In addition, the estimated correlations between all pairs of constructs (see Table 5.7) are below the threshold value of 0.90 (Bagozzi et al. 1991), reflecting that the constructs are distinct.

Table 5.6. Assessment of Discriminant Validity

Constructs	Constrained Model χ^2 (df)	Unconstrained Model χ^2 (df)	$\Delta \chi^2$
Customer Sensing Capability with			
Customer Responding Capability	97.64 (35)	91.23 (34)	6.41
Analytical Ability	57.01 (20)	52.68 (19)	4.33
Interfunctional Coordination	91.09 (35)	80.11 (34)	10.88
Channel Coordination	92.17 (27)	63.93 (26)	28.24
Internal IS Integration	68.89 (27)	62.34 (26)	6.55
External IS Integration	93.77 (27)	59.83 (26)	33.94
Customer Response Speed	62.74 (27)	55.28 (26)	7.46
Customer Responding Capability with			
Analytical Ability	74.26 (20)	61.03 (19)	13.23
Interfunctional Coordination	95.07 (35)	90.31 (34)	4.76
Channel Coordination	77.44 (27)	61.65 (26)	15.79
Internal IS Integration	62.41 (27)	55.86 (26)	6.55
External IS Integration	84.66 (27)	71.31 (26)	13.35
Customer Response Speed	61.79 (27)	57.75 (26)	4.04
Analytical Ability with			
Interfunctional Coordination	48.79 (20)	37.37 (19)	11.42
Channel Coordination	35.79 (14)	24.25 (13)	11.54
Internal IS Integration	39.01 (14)	31.19 (13)	7.82
External IS Integration	27.52 (14)	21.84 (13)	5.68
Customer Response Speed	41.02 (14)	33.93 (13)	7.09
Interfunctional Coordination with			
Channel Coordination	59.43 (27)	52.25 (26)	7.18
Internal IS Integration	50.72 (27)	44.71 (26)	6.01
External IS Integration	44.76 (27)	36.59 (26)	8.17
Customer Response Speed	76.52 (27)	70.79 (26)	5.73
Channel Coordination with			
Internal IS Integration	36.85 (20)	28.82 (19)	8.03
External IS Integration	46.08 (20)	41.07 (19)	5.01
Customer Response Speed	39.29 (20)	34.36 (19)	4.93
Internal IS Integration with			
External IS Integration	46.43 (20)	35.96 (19)	10.47
Customer Response Speed	34.30 (20)	28.09 (19)	6.21
External IS Integration with			
Customer Response Speed	32.93 (20)	24.97 (19)	7.96

5.4.4 Reliability and Descriptive Statistics

Reliability assesses the extent to which scale items are internally consistent (Nunnally and Bernstein 1994). With respect to reliability, Cronbach's alphas for all reflective measures exceed the prescribed 0.70 threshold (Nunnally and Bernstein 1994) as detailed in Table 5.7. We also report inter-construct correlations and descriptive statistics in Table 5.7.

Table 5.7. Inter-Construct Correlations, Descriptive Statistics and Reliabilities*

Construct	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1. Customer Sensing Capability	5.49	1.09	0.87										
2. Customer Responding Capability	5.36	1.23	0.63	0.92									
3. Resource Infrastructure	0.31	0.29	0.28	0.24	-								
4. Cocreation Infrastructure	0.24	0.39	0.21	0.19	0.39	-							
5. User Infrastructure	0.26	0.30	0.30	0.25	0.56	0.49	-						
6. Analytical Ability	3.96	1.62	0.10	0.05	0.05	0.01	0.01	0.86					
7. Interfunctional Coordination	4.65	1.29	0.53	0.26	0.26	0.26	0.23	0.12	0.89				
8. Channel Coordination	4.29	1.28	0.25	0.18	0.18	0.23	0.23	0.04	0.41	0.89			
9. Internal IS Integration	4.45	1.41	0.46	0.29	0.29	0.35	0.38	-0.01	0.60	0.37	0.87		
10. External IS Integration	3.89	1.34	0.22	0.19	0.19	0.32	0.23	0.04	0.45	0.56	0.54	0.88	
11. Action Volume	13.93	11.08	0.24	0.10	0.36	0.23	0.19	0.25	0.23	0.27	0.24	0.09	-
12. Action Repertoire Complexity	0.63	0.04	0.14	0.18	0.06	0.00	0.00	-0.02	0.05	0.00	0.08	0.11	0.12
13. Customer Response Quality	3.67	2.83	0.33	0.22	0.14	0.17	0.05	0.29	0.31	0.24	0.29	0.17	0.49
14. Customer Response Speed	5.03	1.38	0.47	0.57	0.28	0.29	0.23	0.44	0.48	0.33	0.46	0.43	0.24
15. Firm Size	2.67	1.18	0.12	-0.14	0.19	0.11	0.05	0.16	0.01	-0.04	-0.01	-0.03	-0.27
16. Firm Age	50.21	44.44	-0.01	-0.26	-0.08	0.01	-0.19	0.01	-0.07	0.01	-0.16	-0.07	-0.20
17. Economic Impact	3.92	1.46	-0.23	-0.36	-0.06	-0.17	0.01	-0.06	-0.26	-0.07	-0.34	-0.27	-0.01
* Cronbach's alphas are reported in the off-diagonals for reflective measures.													

Construct	12	13	14	15	16	17
12. Action Repertoire Complexity	-					
13. Customer Response Quality	-0.04	-				
14. Customer Response Speed	0.22	0.40	0.88			
15. Firm Size	0.11	-0.08	-0.03	-		
16. Firm Age	0.11	-0.12	-0.01	0.51	-	
17. Economic Impact	-0.15	-0.25	-0.29	0.19	0.23	-
* Cronbach's alphas are reported in the off-diagonals for reflective measures.						

Table 5.8 details descriptive statistics for our dichotomous web-based infrastructure items. Our results show that firms are using a diverse range of web-based tools that allow customers to play various roles in new product development processes.

Table 5.8. Web-Based Infrastructure Descriptive Statistics

Tool ID	Tool	Percentage of "Yes" Responses
IR1	"Contact the Firm" Option	90%
IR2	Feedback Survey	51%
IR3	Chat Rooms	16%
IR4	Company Chat	28%
IR5	Suggestion Box	45%
IR6	Online Poll	28%
IR7	Weblog	21%
IC1	Product Extensions	54%
IC2	Aesthetic Design Toolkit	26%
IC3	Functional Design Toolkit	24%
IU1	User Reviews	40%
IU2	Product Test	22%
IU3	Beta Pages	26%
IU4	Wiki	13%
IU5	Knowledge Yellow Pages	45%
IU6	Bulletin Boards	29%

5.5 Analysis of Common Method Bias

Since common method bias posed a threat to the validity of our study, we attempted to control for it through the design of the study's procedures and statistical controls. We describe our execution of these approaches in the following sections.

5.5.1 Procedural Remedies

Procedural remedies attempt to control method variance through the design of the study. We employed three procedural remedies to control the influence of common method

bias: separation of measurement, protection of respondent anonymity, and reduction of evaluation apprehension.

We separated the measurement of the predictor and criterion variables in a number of ways. First, we created a temporal separation by introducing a time lag between the measurement of customer agility (measured in survey one) and competitive activity (measured in survey two). However, this temporal separation was not feasible when measuring customer agility and the antecedents of customer agility. Hence, for survey one we created a psychological separation by using a cover story to make it appear that the measurement of the predictor variable is not connected with or related to the measurement of the criterion variable. We also distributed two statements in the survey to motivate the respondents and provide separation. These statements are, "You are more than half-way through the survey. Thank you for your effort and patience," and "You have finished 90% of the survey. Almost done!"

We also assured the respondents that their answers would be anonymous, that there were no right or wrong answers, and that they should answer questions as honestly as possible. Although we separated the measurement of customer agility and competitive activity by using two surveys (thus requiring us to link the two data sets using an identifying variable, thereby potentially compromising respondent anonymity), we assured respondents that a computer-generated identification number would be used to link the two data sets and that no other identifiable information would be released to the researchers.

5.5.2 Statistical Remedies

We employed several statistical techniques to diagnose and control for common method bias. Following recommended guidelines (Podsakoff et al. 2003), we conducted

Harman's one-factor test, controlled for the effects of a directly measured latent method factor, and controlled for the effects of a single unmeasured latent method factor. We describe our results in the following sections.

We conducted a Harman one-factor test to diagnose the extent to which common method bias may be a problem. Our results extracted 8 factors from the data which corresponded to the latent variables in our study. The factors accounted for 68.9% of the variance with the first factor accounting for 22.4%. No single factor accounted for a majority of the covariance, suggesting that common method bias might not pose a severe threat to the validity of our study.

We also controlled for the effects of a directly measured latent method factor; namely, social desirability. Social desirability refers to the tendency of some individuals to respond to items more as a result of their social acceptability than their true feelings (Crowne and Marlowe 1964). Two models are compared to assess the potential effect of common method bias. Model A contained items loading on to their respective latent factors, and Model B contained all the items loading on to their respective latent factors and on to the first-order social desirability factor.

We compared the difference in our Satorra-Bentler χ^2 values for both models (Model A $\chi^2 = 489.29$, d.f. = 384; Model B $\chi^2 = 621.84$, d.f. = 354). Results show that the $\Delta\chi^2$ of 132.55, 30 d.f. is significant ($p < 0.001$). Thus, it appears as though social desirability bias may impact our results. However, when comparing the fit indices between Model A and Model B, we note that chi-square differences are sensitive to sample size. Hence, researchers recommend testing for differences in the CFI measure (Byrne 2006). Results indicate that our ΔCFI of 0.001 (Model A

CFI = 0.933; Model B CFI = 0.934) is less than the recommended values of 0.05 (Little 1997) and 0.01 (Cheung and Rensvold 2002). We then examined the significance of the structural parameters for both models. All measurement items loaded high on their respective factor and low on the social desirability factor. Table 5.9 details our results.

Table 5.9. Factor and Social Desirability Method Factor Loadings

Item #	Item	Factor Loading	Method Loading
CS1	We continuously try to discover additional needs of our customers of which they are unaware.	0.64	0.11
CS3	We extrapolate key trends to gain insight into what users in a current market will need in the future.	0.69	0.05
CS4	We continuously try to anticipate our customers' needs even before they are aware of them.	0.82	0.02
CS5	We attempt to develop new ways of looking at customers and their needs.	0.82	0.09
CS6	We sense our customers' needs even before they are aware of them.	0.77	0.16
CR1	We respond rapidly if something important happens with regard to our customers.	0.75	-0.01
CR2	We quickly implement our planned activities with regard to customers.	0.85	-0.02
CR3	We quickly react to fundamental changes with regard to our customers.	0.85	0.06
CR5	When we identify a new customer need, we are quick to respond to it.	0.83	0.01
CR6	We are fast to respond to changes in our customers' product or service needs.	0.89	0.11
AA1	We have IT applications which offer various decision-making tools (such as optimization, scenario analysis, etc.) for managing our relationships with customers.	0.86	0.10
AA2	We have IT applications which offer various simulation and what-if analysis tools for managing our relationships with customers.	0.87	0.09
AA3	We have IT applications which offer various tools that enable us to examine trends in the data for supporting our interactions with customers.	0.73	-0.02
COI1	The activities of functional units are tightly coordinated to ensure better use of our market knowledge.	0.74	0.05

Item #	Item	Factor Loading	Method Loading
COI2	Functions such as R&D, marketing, and manufacturing are tightly integrated in cross-functional teams in product development processes.	0.79	-0.02
COI3	R&D, marketing and other functions regularly share market information about customers, technologies, and competitors.	0.74	0.05
COI4	There is a high level of cooperation and coordination among functional units in setting the goals and priorities for the organization to ensure effective response to market conditions.	0.86	0.07
COI5	Top management promotes communication and cooperation among R&D, marketing, and manufacturing in market information acquisition and use.	0.78	-0.01
COE1	To facilitate operations, our organization's business procedures and routines are linked with the business procedures and routines of our channel partners.	0.74	0.02
COE2	Our way of doing business is closely linked with our channel partners.	0.86	0.03
COE3	The business procedures and routines of our business unit are highly coupled with the business procedures and routines of our channel partners.	0.89	0.07
COE4	Some of our operations are closely connected with the operations of our channel partners.	0.80	0.01
INTI1	...all customer-related data (e.g., service contracts, feedback, etc.)	0.79	0.08
INTI2	...all order-related data (e.g., order status, handling requirements, etc.)	0.75	-0.06
INTI3	...all production-related data (e.g., resource availability, quality, etc.)	0.81	-0.06
INTI4	...all market-related data (e.g., promotion details, future forecasts, etc.)	0.81	0.01
INTE1	Data are entered only once to be retrieved by most applications of our channel partners.	0.70	0.02
INTE2	We can easily share our data with our channel partners.	0.86	0.03
INTE3	We have successfully integrated most of our software applications with the systems of our channel partners.	0.86	0.11
INTE4	Most of our software applications work seamlessly across our channel partners.	0.82	0.12
CRS1	We took quick action when something important happened with regard to our customers.	0.71	-0.03
CRS2	We quickly implemented our planned activities with regard to customers.	0.74	0.03

Item #	Item	Factor Loading	Method Loading
CRS3	When we identified a new customer need, we were swift to execute the appropriate action.	0.97	0.06
CRS4	We were fast to take action in response to changes in our customers' product or service needs.	0.81	0.15

Finally, we controlled for the effects of a single unmeasured latent method factor. Two models are compared to assess the potential effect of common method bias. Model A contained items loading on to their respective latent factors, and Model B contained all the items loading on to their respective latent factors and on to a first-order common method factor. Modeling a latent method factor significantly improves the fit of the model if common method bias accounts for most of the covariance observed in the variables.

We compared the difference in our Satorra-Bentler χ^2 values for both models (Model A $\chi^2 = 489.29$, d.f. = 384; Model B $\chi^2 = 423.15$, d.f. = 354). Results show that the $\Delta\chi^2$ of 66.14, 30 d.f. is significant ($p < 0.001$). Hence, it appears as though common method bias presents a problem. However, taking into account the extent to which chi-square tests may be sensitive to sample size, we again compared CFI measures. When comparing the CFI values between Model A and Model B, results indicate that our ΔCFI of 0.005 (Model A CFI = 0.933; Model B CFI = 0.938) is less than the recommended values of 0.05 (Little 1997) and 0.01 (Cheung and Rensvold 2002). Factor loadings are presented in Table 5.10. These results provide further support that common method bias did not pose a significant threat to the validity of our study. The next section tests the proposed hypotheses in our research model.

Table 5.10. Factor and Unmeasured Latent Method Factor Loadings

Item #	Item	Factor Loading	Method Loading
CS1	We continuously try to discover additional needs of our customers of which they are unaware.	0.68	0.49
CS3	We extrapolate key trends to gain insight into what users in a current market will need in the future.	0.69	0.27
CS4	We continuously try to anticipate our customers' needs even before they are aware of them.	0.82	0.46
CS5	We attempt to develop new ways of looking at customers and their needs.	0.83	0.27
CS6	We sense our customers' needs even before they are aware of them.	0.78	0.34
CR1	We respond rapidly if something important happens with regard to our customers.	0.75	0.49
CR2	We quickly implement our planned activities with regard to customers.	0.85	0.53
CR3	We quickly react to fundamental changes with regard to our customers.	0.85	0.48
CR5	When we identify a new customer need, we are quick to respond to it.	0.83	0.47
CR6	We are fast to respond to changes in our customers' product or service needs.	0.90	0.36
AA1	We have IT applications which offer various decision-making tools (such as optimization, scenario analysis, etc.) for managing our relationships with customers.	0.86	0.44
AA2	We have IT applications which offer various simulation and what-if analysis tools for managing our relationships with customers.	0.87	0.45
AA3	We have IT applications which offer various tools that enable us to examine trends in the data for supporting our interactions with customers.	0.73	0.38
COI1	The activities of functional units are tightly coordinated to ensure better use of our market knowledge.	0.74	0.39
COI2	Functions such as R&D, marketing, and manufacturing are tightly integrated in cross-functional teams in product development processes.	0.79	0.28
COI3	R&D, marketing and other functions regularly share market information about customers, technologies, and competitors.	0.74	0.26
COI4	There is a high level of cooperation and coordination among units in setting the goals and priorities for the organization to ensure effective response to market conditions.	0.86	0.26

Item #	Item	Factor Loading	Method Loading
COI5	Top management promotes communication and cooperation among R&D, marketing, and manufacturing in market information acquisition and use.	0.78	0.32
COE1	To facilitate operations, our organization's business procedures and routines are linked with the business procedures and routines of our channel partners.	0.74	0.38
COE2	Our way of doing business is closely linked with our channel partners.	0.86	0.38
COE3	The business procedures and routines of our business unit are highly coupled with the business procedures and routines of our channel partners.	0.89	0.34
COE4	Some of our operations are closely connected with the operations of our channel partners.	0.80	0.22
INTI1	...all customer-related data (e.g., service contracts, feedback, etc.)	0.79	0.24
INTI2	...all order-related data (e.g., order status, handling requirements, etc.)	0.75	0.23
INTI3	...all production-related data (e.g., resource availability, quality, etc.)	0.81	0.27
INTI4	...all market-related data (e.g., promotion details, future forecasts, etc.)	0.82	0.32
INTE1	Data are entered only once to be retrieved by most applications of our channel partners.	0.70	0.23
INTE2	We can easily share our data with our channel partners.	0.86	0.29
INTE3	We have successfully integrated most of our software applications with the systems of our channel partners.	0.86	0.25
INTE4	Most of our software applications work seamlessly across our channel partners.	0.84	0.30
CRS1	We took quick action when something important happened with regard to our customers.	0.70	0.34
CRS2	We quickly implemented our planned activities with regard to customers.	0.85	0.23
CRS3	When we identified a new customer need, we were swift to execute the appropriate action.	0.87	0.22
CRS4	We were fast to take action in response to changes in our customers' product or service needs.	0.78	0.29

5.6 Structural Model and Hypothesis Testing

In this section we test structural properties and hypotheses of the proposed research model. We test main effect hypotheses related to customer agility (H1, H3, and H4) by examining the significance of structural links among the constructs of the hypothesized main effects. Following this, we test moderation hypotheses related to customer agility (H2, H5, and H6) with procedures and test statistics suggested in prior research (Carte and Russell 2003; Marsh et al. 2004). Finally, we test the relationships between customer agility and measures of competitive activity (H7-H10).

5.6.1 Analyses of Main Effects on Customer Agility: H1, H3, and H4

Per our decomposition of customer agility into two components, customer sensing capability and customer responding capability, we tested the main effects on each component. Model A consisted of three relationships: resource infrastructure (H1a), cocreation infrastructure (H1b), and user infrastructure (H1c) were modeled as antecedents to customer sensing capability. Our regression results show that resource infrastructure ($\beta = 0.16$, $p < 0.05$) and user infrastructure ($\beta = 0.18$, $p < 0.05$) are significantly related to customer sensing capability. Cocreation infrastructure is not significantly related to customer sensing capability ($\beta = 0.06$, n.s.). Thus, H1a and H1c are supported, and H1b is not supported. The R^2 for customer sensing capability was 0.10. We also computed variance inflation factors (VIF) to detect multicollinearity between our infrastructure measures. All of our VIF values were less than 2.00, thus indicating an absence of multicollinearity in our analysis (Hair et al. 1998).

Model B consisted of two hypothesized relationships: interfunctional coordination and customer responding capability (H3), and channel coordination and customer responding

capability (H4). We also included firm size as a control variable for customer responding capability. Mardia's normalized estimate was 20.14, suggesting that our data were not normally distributed. Thus, we relied on robust fit statistics. Model B performed well in terms of model fit (Satorra-Bentler χ^2 = 267.84, d.f. = 216; CFI = 0.97; RMSEA = 0.037). Our results show that interfunctional coordination (β = 0.52, $p < 0.001$) and channel coordination (β = 0.16, $p < 0.01$) are both significantly related to customer responding capability, supporting H3 and H4, respectively. Moreover, firm size was significantly related to customer responding capability (β = -0.16, $p < 0.01$). The R^2 for customer responding capability was 0.41. Figure 5.1 depicts the results for Models A and B.

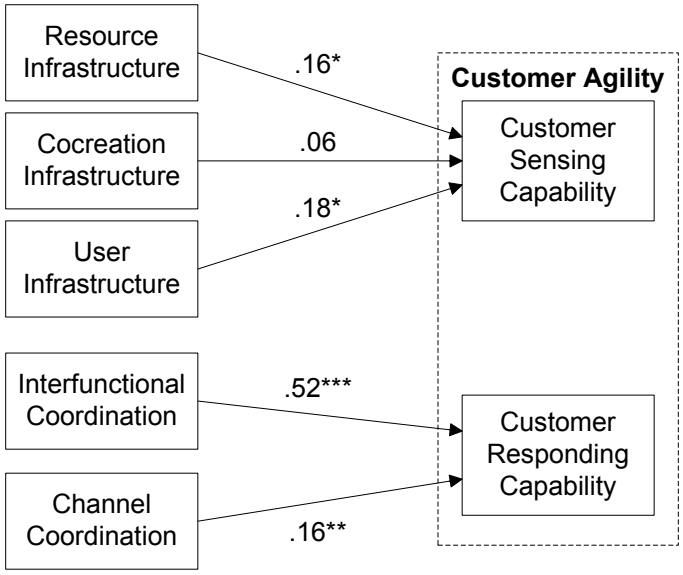


Figure 5.1. Results of Model Testing for Hypotheses H1, H3, and H4

5.6.2 Analyses of Moderation Effects on Customer Agility: H2, H5, and H6

We proposed several moderation effects in our research model. H2 states that the relationship between three constructs – resource infrastructure (H2a), cocreation infrastructure (H2b), and user infrastructure (H2c) – and customer sensing capability will each be positively moderated by analytical ability. Since our web-based infrastructure measures and our interaction (infrastructure * analytical ability) measures consisted of single indicators, we employed linear regression to test H2. H5 states that the relationship between interfunctional coordination and customer responding capability will be positively moderated by internal IS integration. Finally, H6 states that the relationship between channel coordination and customer responding capability will be positively moderated by external IS integration. Since all of these constructs are measured with multiple indicators, we employed EQS to test H5 and H6.

In order to avoid issues with multicollinearity, all independent variables were mean-centered (Aiken and West 1991; Cortina 1993). We created interaction terms related to customer sensing capability by multiplying each web-based infrastructure index measure by analytical ability (where analytical ability is calculated as the average of our three analytical ability indicators).

We followed guidelines proposed by Marsh et al. (2004) to test moderation effects using EQS. We created interaction terms by taking the product of the mean-centered indicators. Specifically, we multiplied the highest loading indicator of one construct, e.g., interfunctional coordination, by the highest loading indicator of the other construct, e.g., internal IS integration. We followed this process for each pair of indicators from highest to lowest. We retained

indicators for our interaction terms that exhibited sufficiently high factor loadings (>= 0.70). Table 5.11 details the main indicators and their interaction terms for all interaction effects.

Table 5.11. Main Indicators and Interaction Terms

Variable	Main Indicators	Interaction Term
Resource Infrastructure * Analytical Ability	IR * AA	IR_AA
Cocreation Infrastructure * Analytical Ability	IC * AA	IC_AA
User Infrastructure * Analytical Ability	IU * AA	IU_AA
Interfunctional Coordination * Internal IS Integration	COI4 * INTI3 COI5 * INTI4 COI2 * INTI1	INT_COI1 INT_COI2 INT_COI3
Channel Coordination * External IS Integration	COE3 * INTE3 COE2 * INTE2 COE4 * INTE4	INT_COE1 INT_COE2 INT_COE3

We used a hierarchical analysis approach (Venkatraman 1989a) to evaluate our moderation hypotheses. Table 5.12 details our results with customer sensing capability as dependent variable. Our results indicate that analytical ability moderates two of three relationships – resource infrastructure ($\beta = 0.29$, $p < 0.05$) and user infrastructure ($\beta = 0.26$, $p < 0.05$) – supporting H2a and H2c. However, analytical ability does not moderate the relationship between cocreation infrastructure and customer sensing capability. Thus, H2b is not supported. The R^2 for the model including the interaction effects was 0.14.

Table 5.12. Results of Hierarchical Regression Analysis for Customer Sensing Capability

Variable	Main Effects	Interactions Included
Constant Term	-0.49**	-0.43**
Resource Infrastructure (IR)	0.16*	0.12
Cocreation Infrastructure (IC)	0.06	0.03
User Infrastructure (IU)	0.18*	0.26*
Analytical Ability (AA)	0.09	0.08
IR * AA		0.29*
IC * AA		0.14
IU * AA		0.26*
R^2	0.11	
Change in R^2		0.03
F-Statistic	7.56***	6.88***
* p < 0.05; ** p < 0.01; *** p < 0.001		

Table 5.13 provides results for our hierarchical analysis with customer responding capability as dependent variable. Internal IS integration moderates the relationship between interfunctional coordination and customer responding capability ($\beta = 0.11$, $p < 0.05$), supporting H5. However, external IS integration does not moderate the relationship between channel coordination and customer responding capability ($\beta = 0.05$, n.s.). Thus, H6 is not supported. Our model performed well in terms of model fit (Satorra-Bentler $\chi^2 = 444.52$, d.f. = 350; CFI = 0.95; RMSEA = 0.039) with an R^2 of 0.47.

Table 5.13. Results of Hierarchical SEM Analysis: Customer Responding Capability

Variable	Main Effects	Interactions Included
Interfunctional Coordination (COI)	0.42***	0.41***
Channel Coordination (COE)	0.19*	0.14*
Internal IS Integration (INTI)	0.21**	0.23**
External IS Integration (INTE)	0.06	0.05
Firm Size	-0.15*	-0.13*
COI * INTI		0.11*
COE * INTE		0.05
R^2	0.45	
Change in R^2		0.02
* p < 0.05; ** p < 0.01; *** p < 0.001		

5.6.3 Analyses of Main Effects on Competitive Activity

In the following sections we test relationships between agility alignment and competitive activity. We have three measures of agility alignment – moderation, matching and mediation – and four measures of competitive activity – action volume, action repertoire complexity, customer response quality, and customer response speed. Since our agility alignment measures require different analyses, e.g., moderation, polynomial regression, mediation, we organize our results by alignment perspective. Since action volume consists of count data, we transformed action volume as the logarithm to aid interpretation. We also included firm size, firm age and economic impact as control variables for all dependent variables.

5.6.3.1 Agility Alignment as Moderation

We used a hierarchical regression approach to test the effects of agility alignment (as moderation) on our competitive activity outcomes; specifically, action volume, action repertoire complexity, and customer response quality. All independent variables were mean-centered.

Agility alignment (as moderation) is calculated as the multiplicative interaction of customer sensing capability and customer responding capability.

Our results indicate that customer sensing capability does not moderate the relationships between customer responding capability and action volume or action repertoire complexity (see Table 5.14). Thus, H7a and H8a are not supported. However, agility alignment as moderation does have a significant effect on customer response quality. Specifically, customer sensing capability moderates the relationship between customer responding capability and customer response quality ($\beta = 0.18$, $p < 0.05$), thus supporting H9a. Economic impact also had a significant effect on customer response quality ($\beta = -0.22$, $p < 0.05$). The R^2 for the model including the interaction effects was 0.27.

Table 5.14. Results of Hierarchical Regression Analysis: Agility Alignment as Moderation

	Action Volume		Action Repertoire Complexity		Customer Response Quality	
Variable	**Main Effects**	**Interaction Included**	**Main Effects**	**Interaction Included**	**Main Effects**	**Interaction Included**
Customer Sensing Capability (CS)	0.27	0.27	0.13	0.08	0.29*	0.30*
Customer Responding Capability (CR)	0.15	0.15	0.01	0.03	0.05	0.12
Firm Size	-0.30*	-0.30*	-0.03	-0.02	-0.01	0.00
Firm Age	0.05	0.05	0.12	0.09	0.14	0.12
Economic Impact	-0.02	-0.02	-0.09	-0.11	-0.22*	-0.22*
CS * CR		0.01		0.14		0.18*
R^2	0.14		0.04		0.23	
Change in R^2		0.00		0.01		0.04
* $p < 0.05$						

5.6.3.2 Agility Alignment as Matching

Difference scores are often used to represent congruence (i.e., fit, match, similarity) between two constructs, which is then viewed as a predictor of some outcome (Chan et al. 1997; Van de Ven and Drazin 1985). These scores have usually consisted of the algebraic, absolute, or squared difference between two component measures (e.g. Alexander and Randolph 1985; Turban and Jones 1988) or the sum of absolute or squared differences between profiles of component measures (Drazin and Van de Ven 1985; Venkatraman 1990).

However, difference scores suffer from several substantive and methodological problems (Johns 1981; Klein et al. forthcoming). An alternative procedure involves the use of polynomial regression equations containing the component measures composing the difference and certain higher-order terms, such as the squares of both component measures and their product (Edwards and Parry 1993). These equations allow a researcher to avoid numerous problems associated with difference scores but nonetheless obtain direct tests of theoretical models relevant to the study of congruence. Polynomial regression analysis has been widely used in the study of research involving congruence (Edwards 2009).

We used polynomial regression to test hypotheses involving agility alignment as matching. Specifically, we followed methodological guidelines recommended by Edwards and colleagues (Edwards 1994; Edwards and Cooper 1990; Edwards and Parry 1993). We used the following general polynomial regression equation:

$$Z = \beta_0 + \beta_1 X + \beta_2 Y + \beta_3 X^2 + \beta_4 XY + \beta_5 Y^2 + e.$$

This equation shows that a squared difference imposes four constraints: (1) The coefficient on X is 0, (2) the coefficient on Y is 0, (3) the coefficients on X^2 and Y^2 are equal, and (4) the coefficients on X^2, XY, and Y^2 sum to 0. Given the third constraint, this is equivalent to stating that the coefficient on XY is twice as large as the coefficient on either X^2 or Y^2, but opposite in sign (Edwards 1994). This equation applied to our study results in the following:

$$\text{CompetitiveActivity} = \beta_0 + \beta_1 CS + \beta_2 CR + \beta_3 CS^2 + \beta_4 (CS*CR) + \beta_5 CR^2 + \beta_6 \text{FirmSize} + \beta_7 \text{FirmAge} + \beta_8 \text{EconomicImpact} + e.$$

where CS refers to customer sensing capability and CR refers to customer responding capability. We also include firm size, firm age and economic impact as control variables. Table 5.15 details the results of our polynomial regression analyses for action repertoire complexity (H8b) and customer response quality (H9b).

Table 5.15. Results of Polynomial Regression Analyses

	Action Repertoire Complexity	**Customer Response Quality**
Intercept	0.63	3.43
Customer Sensing Capability (CS)	-0.01	0.35*
Customer Responding Capability (CR)	-0.01	0.02
CS^2	0.01	0.05
CS * CR	-0.01	-0.01
CR^2	0.01	-0.03
Firm Size	0.02	0.01
Firm Age	0.01	0.02
Economic Impact	-0.01	-0.39*
R^2	0.09	0.25
Table entries are unstandardized regression coefficients for equations with all predictors entered simultaneously. * $p < 0.05$		

The R^2 values for action repertoire compleixty and customer response quality were 0.09 and 0.25, respectively. However, simply inspecting the signs and magnitudes of the coefficients in Table 5.17 reveals little as to the shape of the surface they represent. Response surface methodology (Khuri and Cornell 1987) provides the basis necessary for describing and testing the required features of surfaces corresponding to quadratic regression equations. We focused on three key features of these surfaces (Edwards and Parry 1993). The first is the stationary point (i.e., the point at which the slope of the surface is 0 in all directions), which corresponds to the overall minimum, maximum, or saddle point of the surface. The second feature is the principal axes of the surface, which run perpendicular to one another and intersect at the stationary point. Finally, the third feature is the slope of the surface along various lines of interest, such as the principal axes and the line along which the component variables are equal (the Y = X line).

We do not construct a surface for agility alignment predicting action repertoire complexity because all of the regression coefficients are very low and non-significant (see Table 5.15). Figure 5.2 depicts a surface for agility alignment (sense and response) predicting customer response quality.

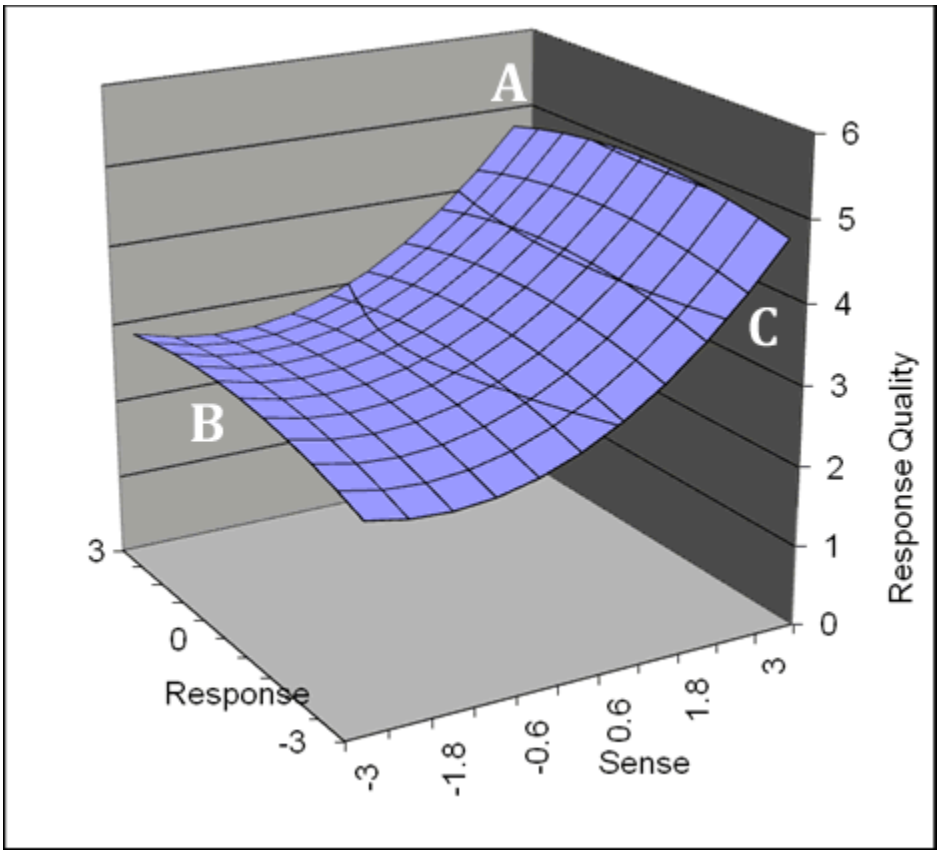


Figure 5.2. Surface for Agility Alignment Predicting Customer Response Quality

Figure 5.2 depicts four basic effects. First, customer response quality is higher when customer sensing capability and customer responding capability are aligned than when they are non-aligned. Also, customer response quality is higher when sensing and responding values are both high than when they are both low (point A). Third, the response curve is slightly concave, which tells us that customer response quality is greatest when customer responding capability is at a high to medium level (i.e., customer response quality tapers off for low response firms, see point B). Finally, the sense curve shows us that high sensers score much higher on customer response quality than low and medium sensers (point C).

5.6.3.3 Agility Alignment as Mediation

Mediation refers to an indirect effect of an independent variable on a dependent variable that passes through a mediator variable (Shrout and Bolger 2002). For our study, agility alignment as mediation implies that the effect of customer sensing capability on competitive activity is mediated by customer responding capability (see Figure 2.4 in Chapter 2). Researchers have traditionally used a four step approach outlined by Baron and Kenny (1986). However, scholars have recently suggested an alternative approach which calculates the indirect effect and tests for its significance (MacKinnon et al. 2002). Termed a product of coefficients test, in this approach the regression coefficient for the indirect effect represents the change in the outcome variable (competitive activity) for every unit change in the independent variable (customer sensing capability) that is mediated by the intervening variable (customer responding capability). We adopt the Sobel (1982) product of coefficients approach, which involves two models:

$$CompActivity = \beta_0 + \beta_1 CS + \beta_2 CR + \beta_3 FSize + \beta_4 FAge + \beta_3 EconImpact + e \quad \text{(Equation 1)}$$

$$CR = \beta_0 + \beta_1 CS + e \quad \text{(Equation 2)}$$

where CS refers to customer sensing capability and CR refers to customer responding capability. We also include firm size, firm age and economic impact as control variables for competitive activity. The indirect effect is calculated as

$$B_{indirect} = (B_2)(B)$$

where B_2 is the partial regression coefficient for customer responding capability predicting competitive activity (from Equation 1), and B is the coefficient for customer sensing capability predicting customer responding capability (from Equation 2).

Table 5.16 provides the results of our mediation tests. We found mixed support for the relationships between agility alignment as mediation and measures of competitive activity. Specifically, customer responding capability mediates the relationships between 1) customer sensing capability and action volume ($\beta = 0.04$; $p < 0.05$) as well as 2) customer sensing capability and customer response speed ($\beta = 0.39$; $p < 0.001$). On the other hand, customer responding capability does not mediate the relationships between 1) customer sensing capability and action repertoire complexity and 2) customer sensing capability and customer response quality. Our results show support for H7b and H10, with no support for H8c and H9c.

Table 5.16. Results of Mediation Analyses

Dependent Variable	**Sensing → Responding**	**Responding → Activity**	**Mediating Effect**	**Standard Error for Mediating Effect**	**Z-statistic**
Action Volume	0.76	0.07	0.05*	0.024	2.10
Action Repertoire Complexity	0.76	0.01	0.00	0.004	1.19
Customer Response Quality	0.76	0.09	0.07	0.222	0.30
Customer Response Speed	0.76	0.52	0.39**	0.105	3.73
Table entries are unstandardized regression coefficients. * $p < 0.05$; ** $p < 0.001$					

Table 5.17 summarizes the results of our hypothesis testing. In the next section we discuss our analysis of qualitative data.

Table 5.17. Summary of Hypothesis Testing

Item	Hypothesis	Supported?
H1a	Resource infrastructure will be positively related to customer sensing capability.	Yes
H1b	Cocreation infrastructure will be positively related to customer sensing capability.	No
H1c	User infrastructure will be positively related to customer sensing capability.	Yes
H2a	The relationship between resource infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between resource infrastructure and customer sensing capability.	Yes
H2b	The relationship between cocreation infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between cocreation infrastructure and customer sensing capability.	No
H2c	The relationship between user infrastructure and customer sensing capability will be moderated by analytical ability: the greater the analytical ability, the stronger the positive association between user infrastructure and customer sensing capability.	Yes
H3	Interfunctional coordination will be positively related to customer responding capability.	Yes
H4	Channel coordination will be positively related to customer responding capability.	Yes
H5	The relationship between interfunctional coordination and customer responding capability will be moderated by internal IS integration: the greater the internal IS integration, the stronger the positive association between interfunctional coordination and customer responding capability.	Yes
H6	The relationship between channel coordination and customer responding capability will be moderated by external IS integration: the greater the external IS integration, the stronger the positive association between channel coordination and customer responding capability.	No
H7a	The relationship between customer responding capability and action volume will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and action volume.	No

Item	Hypothesis	Supported?
H7b	Customer responding capability mediates the impact of customer sensing capability on action volume.	Yes
H8a	The relationship between customer responding capability and action repertoire complexity will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and action repertoire complexity.	No
H8b	The higher the "match" between customer sensing capability and customer responding capability, the higher the action repertoire complexity.	No
H8c	Customer responding capability mediates the impact of customer sensing capability on action repertoire complexity.	No
H9a	The relationship between customer responding capability and customer response quality will be moderated by customer sensing capability: the greater the customer sensing capability, the stronger the positive association between customer responding capability and customer response quality.	Yes
H9b	The higher the "match" between customer sensing capability and customer responding capability, the higher the customer response quality.	Yes
H9c	Customer responding capability mediates the impact of customer sensing capability on customer response quality.	No
H10	Customer responding capability mediates the impact of customer sensing capability on customer response speed.	Yes

5.7 Content Analysis of Qualitative Data

We performed an analysis of our open-ended survey questions. Specifically, we conducted a content analysis (Weber 1990) of respondents' qualitative responses to a set of open-ended questions on the types of actions that their organizations undertook in response to customer feedback, input or suggestions; why they executed those actions; what they had to do to successfully implement those actions; how they evaluated the success of those actions; and how they potentially used IT during these processes. The purpose of this analysis was to qualitatively triangulate and validate our earlier quantitative findings and possibly gain further insight into the nature and causes of the hypothesized associations. These open-ended questions were included in the second survey (see Table 5.18).

Table 5.18. Open-Ended Questions for Survey Two

Open-Ended Questions: Responding to Customers
1. Please briefly describe this action: 2. Please briefly describe the basis or criterion on which you decided to execute this action: 3. Please briefly describe what your business unit had to do to successfully implement this action: 4. Please briefly describe how you evaluated whether this action was successful: 5. If applicable, please briefly describe how your organization used information technology during this process (e.g., we collected customer data through our web site, we used software to analyze customer data):
Stem: *Among the actions your business unit took in 2008, think of ONE in particular that stood out as being the most successful.*

A total of 78 textual responses were obtained. The qualitative data was content analyzed into general themes representing our questions of interest such as types of actions, action triggers, and action success evaluation. We categorized actions into the five categories (and their respective keywords) discussed in Chapter 4: pricing, marketing, product, capacity, and alliance. Our results showed that approximately 50% of the actions were related to new products/services or major upgrades to existing products/services, 33% to major pricing initiatives, 10% to marketing campaigns, 5% to new alliances, and 2% to major changes in product/service capacity.

Respondents noted several ways in which they sensed customer-based opportunities for innovation and competitive action. A common mechanism used to sense opportunities was consumer surveys, many of which were conducted over the Internet. The following quote illustrates how one organization absorbed customer feedback through its website and made changes based on that feedback:

> *Our products were only available online in the past. We have had a lot of feedback from our customers through our website about making our products more accessible. We are now in the process of bringing our product into stores across the country.*

Our content analysis also showed that organizations had to undertake a number of initiatives in order to execute an action. For example, one organization "had to get several departments to work together for a common goal," while another organization "put more pressure on suppliers to deliver goods faster." Several organizations disseminated information via promotions and marketing campaigns. One example of organizational functions working together to upgrade a product is illustrated in the following:

> *Engineering went through the complete unit drawing and determined what units had to be included in the kit. Product Manager then went through the drawing to determine what else had to be included in the kit so that it was a complete success in fixing the problem.*

We examined how organizations evaluated the success of their customer-based actions. The vast majority of our respondents evaluated the success of their organization's actions on quantitative measures, such as sales, number of new customers, and customer satisfaction surveys. One respondent noted that the release of a new product line resulted in "good customer response at a recent trade show." Another organization increased its production capacity and noticed "improvement in delivery times and less complaints from customers."

Finally, we content analyzed the ways in which organizations used IT to sense, respond to, and evaluate customer-based market opportunities. Several respondents noted the use of web-based feedback mechanisms such as surveys, web forms, and online forums. A number of organizations leveraged IT-based analytical applications to "analyze our customer data" and to

"analyze and track sales data" in support of their decision-making processes. The following quote demonstrates how one organization combined web-based feedback with analytical tools to help make decisions regarding its product offerings:

> *We used our customer survey and feedback web sites along with analysis of customer purchasing patterns and licensing data. We streamlined licensing by eliminating some separate products and bundling them.*

Our content analysis provided deeper insight into the relationships hypothesized in our research model. Specifically, our qualitative data showed us why organizations executed their actions; what they had to do to successfully implement those actions; how they evaluated the success of those actions; and how they used IT during these processes. We discuss these findings and our quantitative results in greater detail in the next chapter.

5.8 Chapter Summary

This chapter described the results of our data analyses. We discussed the development of our surveys, both of which included a pretest and pilot. We described our data collection effort for both surveys and our data imputation methods. Demographic analyses revealed that our respondents were highly qualified to answer the survey questions. Furthermore, our sample characteristics informed us that our data characterize the firms defined in our sample frame (e.g., high tech firms with a diverse set of web-based tools). We tested for possible effects of non-response bias and found that problems due to non-response bias can be ruled out for our study.

We assessed our constructs' measurement properties, including convergent validity, discriminant validity, reliability, and descriptive statistics. Following this we described our

procedural remedies taken to reduce effects related to common method bias. We also employed three statistical techniques to diagnose and control for common method bias: Harman's one-factor test, including a directly measured latent method factor (social desirability bias), and including a single unmeasured latent method factor. Our statistical results shown provided support that common method bias did not pose a significant threat to the validity of our study.

We employed a number of analytic techniques to test our research model, including linear regression, polynomial regression, and structural equation modeling. Our results supported 11 of our 19 hypotheses. Specifically, we found that resource infrastructure and user infrastructure are both positively related to customer sensing capability. Cocreation infrastructure is not related to customer sensing capability. However, interfunctional coordination and channel coordination are both positively related to customer responding capability.

For our moderation hypotheses and customer agility, we found that analytical ability strengthens two relationships: resource infrastructure-sensing capability and user infrastructure-sensing capability. On the other hand, analytical ability does not moderate the relationship between cocreation infrastructure and customer sensing capability. We also found that internal IS integration strengthens the relationship between interfunctional coordination and customer responding capability. Our analysis provided no support for the moderating role of external IS integration on the relationship between channel coordination and customer responding capability.

Our analyses found mixed support for the relationship between customer agility alignment and competitive activity. When conceptualized as moderation, agility alignment is positively related to customer response quality. When viewed as matching, agility alignment is related to customer response quality. Finally, our results show that agility alignment as mediation has significant effects on action volume and customer response speed. One interesting finding is that, across all three perspectives, agility alignment has no effect on action repertoire complexity.

Finally, we presented the results of our qualitative analyses. Our content analysis provided greater insight into why firms execute their customer-based actions; what they have to do to successfully implement those actions; how they assess the impact of those actions; and how they use IT during these processes.

In the next chapter we discuss in greater detail the results of our findings, implications for research and practice, and concluding thoughts.

CHAPTER SIX: DISCUSSION

6.0 Introduction

In this chapter we discuss key findings from our data analyses, implications for research, and implications for managers. We also note this study's limitations and directions for future research, followed by concluding thoughts.

6.1 Key Findings

We discuss our findings in the following sections with respect to the three research questions posed in Chapter 1:

- What is customer agility?
- How does information technology facilitate the sensing and responding components of customer agility?
- What is the effect of customer agility on competitive activity?

6.1.1 Better Conceptualization of Customer Agility

Our literature review revealed that organizational agility – customer agility in particular – is a newcomer to the organization science stage. As such, definitions of agility are diverse and far-flung, resulting in little consensus as to what constitutes agility and why agility is important to researchers and managers. Divergence in these conceptualizations and definitions created further difficulties in considering how to measure agility. Moreover, the fuzzy boundaries surrounding agility led to substantial conceptual overlap with established organizational concepts such as absorptive capacity and market orientation.

We sought to clear the confusion surrounding organizational agility and, in particular, customer agility. Our literature review revealed that agility is an outgrowth of organizational adaptation research and manufacturing agility literature. In turn, we noted salient characteristics of agility:

- Agility is an *organizational capability*, not a static asset. Thus, agility must be developed and maintained by the firm. Our study also found that firms can put in place certain assets (e.g., web-based infrastructure) and capabilities (e.g., interfunctional coordination) that contribute to its customer agility. To put it succinctly, agility is something a firm does well or does poorly.
- Agility constitues *sense and response*. While prior research noted that agile firms sense and respond to environmental change (Zaheer and Zaheer 1997), we found that sensing and responding are distinct capabilities that, together, enhance a firm's competitive activity. Furthermore, we also recognized that the alignment between sensing and responding capabilities makes a difference in terms of action volume, customer response quality, and customer response speed. Hence, not only does agility comprise sense and response, the relationship between sense and response is important to take into account.
- Agile firms are *quick to respond* to environmental change. Agility is a critical success factor for firms competing in dynamic, hypercompetitive environments (D'Aveni 1994). Our results support prior research by showing that agile firms are quick to sense and respond to customer-based opportunities for innovation and competitive action.

We synthesized these characteristics into a clear defintion of customer agility: the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. We developed a measure for customer agility based on prior research, and we also presented valid measurement properties of our customer agility measure. Finally, we conceptualized antecedents and consequences of customer agility in a comprehensive yet parsimonious research model. We discuss these findings in the following sections.

6.1.2 Information Technology Facilitates Customer Agility

We conceptualized and empirically tested a research model with distinct antecedents to customer agility's two components – sensing and responding. We theorized that "knowledge-based" constructs would impact customer sensing capability, and "process-based" constructs would affect customer responding capability. Within this framework, IT plays two roles: 1) IT exhibits direct effects on customer agility and 2) IT magnifies the relationship between organizational resources and customer agility. To faciliate our discussion, we depict the results of our empirical analyses in Figure 6.1. We discuss these results in the following sections.

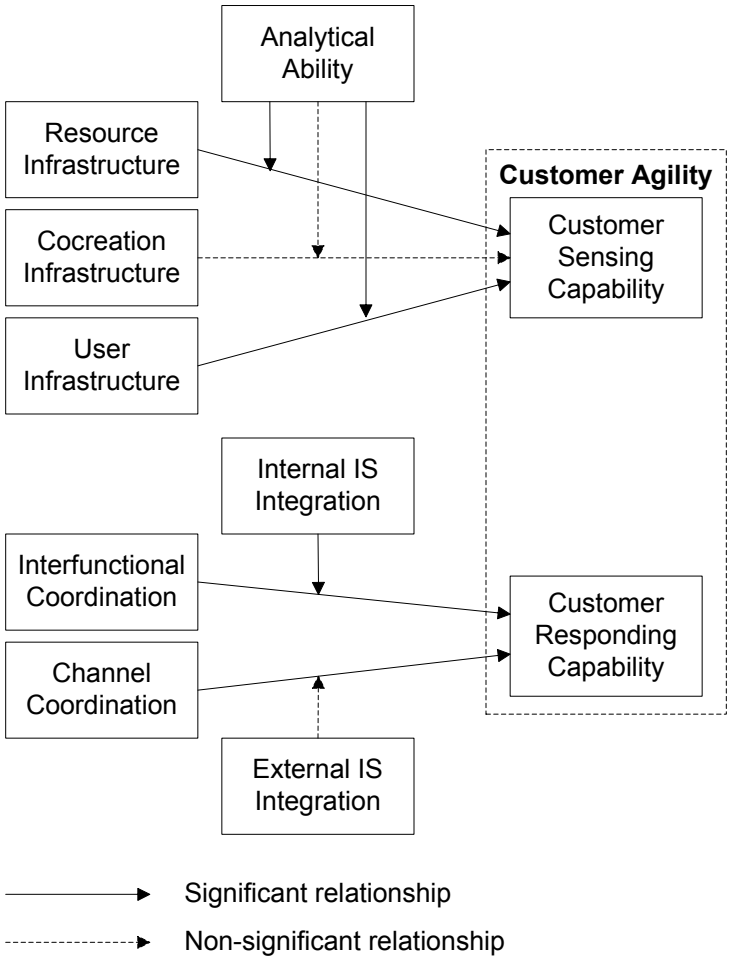


Figure 6.1. Results of Testing Antecedents to Customer Agility

6.1.2.1 Antecedents to Customer Sensing Capability

Our analysis finds that web-based resource infrastructure and user infrastructure each have a significant effect on customer sensing capability. Firms are leveraging these powerful tools to produce three important benefits when working with customers in new product development: (1) the direction of communication, (2) the intensity and richness of the interaction, and (3) the size and scope of the audience. A web-based infrastructure enables interactive firm-to-customer and customer-to-customer dialogues that help firms gain better

insight into shifting customer needs and preferences. Furthermore, web-based tools allow firms to tap into the social knowledge created from these rich interactions. Finally, a web-based infrastructure allows a firm to substantially increase the size and scope of its audience, thereby allowing it to sense a greater number and diverse range of customer-based opportunities for innovation and competitive action.

We also find that analytical ability plays a key role in the nomological network surrounding web-based infrastructure and customer sensing capability. Specifically, the greater a firm's analytical ability, the stronger the positive association between the firm's web-based resource infrastructure and its customer sensing capability. Furthermore, analytical ability also strengthens the relationship between web-based user infrastructure and customer sensing capability. Although practitioners and scholars have recently touted the potential power of analytics in contemporary firms, our study is one of the first to provide empirical evidence of analytics' synergistic role in facilitating a firm's customer sensing capability. It is important to note that analytical ability does not exhibit a direct effect on customer sensing capability. Rather, data streaming in from the firm's web-based infrastructure, coupled with the firm's ability to leverage analytical tools to transform data into knowledge, create complementary synergies that have powerful effects on the firm's ability to sense customer-based market opportunities.

Our analysis finds no support for a relationship between cocreation infrastructure and customer sensing capability. Although this result is surprising, there are a number of probable factors at play here. First, cocreation tools are not yet as widely diffused as resource and user tools (Prandelli et al. 2006). As a result, there was limited variance in our cocreation

infrastructure measure. Second, contrary to our theorizing, firms may not be collecting and/or using data collected from customers' use of cocreation tools. In turn, limited or no use of this "clickstream" data would have no impact on the firm's customer sensing capability. Future research should investigate the nature of cocreation tools and how they might contribute to customer agility.

6.1.2.2 Antecedents to Customer Responding Capability

We found that interfunctional coordination and channel coordination are significantly related to customer responding capability. Thus, the firm's ability to respond to customer-based market opportunities depends on efficient and effective coordination and alignment between (a) internal organizational functions and (b) the focal firm and its key channel partners. While these results are consistent with prior research on market orientation (Kirca et al. 2005), to the best of our knowledge, our study is the first that includes both internal (interfunctional) and external (channel partners) coordination as antecedents to customer responding capability.

We also posited that internal IS integration and external IS integration would positively moderate the interfunctional and channel relationships, respectively. Our results show that the greater a firm's internal IS integration, the stronger the positive association between the firm's interfunctional coordination and its customer responding capability. The transparency, consistency and communication capabilities provided by integrated information systems enable organizational functions to effectively share information. In turn, complementary synergies arise from the firm's coordination and internal IS integration capabilities, thereby allowing it to respond more effectively and quickly to customer-based market opportunities.

Our analysis finds no support for the moderating role of external IS integration in the relationship between channel coordination and customer responding capability. There may be a number of reasons for this unexpected finding. Although we found that channel coordination facilitates the focal firm's ability to respond to customer-based opportunities, there are a variety of reasons for which a firm shares data with its channel partners, some of which may not be relevant to the coordination-response relationship. For instance, firms may integrate their IT systems with certain channel partners in order to manage the flow of materials and finished goods; share operational, tactical and strategic information; and increase financial flows driven by workflow events (Rai et al. 2006). Furthermore, a supply chain consists of many types of partners, each of whom have specific, unique roles to each other. Our conceptualization of channel partners may not have investigated the appropriate types of partnerships required to enhance a firm's ability to respond to market opportunities.

6.1.3 Customer Agility Impacts Competitive Activity

We hypothesized that the alignment between customer sensing capability and customer responding capability would positively impact four outcome variables: action volume, action repertoire complexity, customer response quality, and customer response speed. We also considered three perspectives on agility alignment: moderation, matching and mediation. When applied to customer agility, the moderation perspective implies that the impact of customer responding capability on competitive activity varies across different levels of customer sensing capability. With respect to matching, the stronger the match between customer sensing capability and customer responding capability, the greater the effect of customer agility on competitive activity. Finally, the mediation perspective posits that customer responding

capability mediates the relationship between customer sensing capability and competitive activity. Table 6.1 describes the results of our analyses.

Table 6.1. Results of Testing Agility-Activity Relationships

Type of Competitive Activity	Agility Alignment Perspective	Supported?
Action Volume	Moderation	No
	Mediation	Yes
Action Repertoire Complexity	Moderation	No
	Matching	No
	Mediation	No
Customer Response Quality	Moderation	Yes
	Matching	Yes
	Mediation	No
Customer Response Speed	Mediation	Yes

6.1.3.1 Action Volume

Action volume refers to the total number of actions a firm takes in a given time period. We posited that two types of agility alignment – moderation and mediation – impact action volume. Our results show that customer sensing capability does not moderate the relationship between customer responding capability and action volume. This nonsignificant finding may indicate that competitive activity takes place regardless of a firm's customer sensing capabilities. In other words, firms respond because they can. However, this response may not be appropriate or effective due to a lack of alignment between sensing and responding. Thus, multiplicative effects of customer sensing capability and customer responding capability do not necessarily lead to greater volume of competitive actions.

However, our results show that customer responding capability mediates the influence of customer sensing capability on action volume. Although a firm may have a strong sensing

capability, this result shows that the firm must also have a minimum ability to respond in order to take action. In other words, the effect of a firm's sensing capability on action volume is partially dependent on its ability to respond to customer-based opportunities.

6.1.3.2 Action Repertoire Complexity

We also conceptualized the relationship between agility alignment (moderation, matching and mediation) and action repertoire complexity. Our results find no support for any of our three proposed hypotheses. Greater alignment between sensing and responding capabilities does not lead to more complex repertoires of competitive activity, i.e., greater mix of pricing, marketing, product, capacity, and alliance actions. We argued that by taking into account customers' expressed and latent needs, a firm will be more likely to execute a more diverse range of actions. However, our lack of support for the customer agility-action repertoire complexity relationship may be due to the fact that since customers are most familiar with a firm's products and services, as opposed to alliances or capacity levels, customers are more likely to provide information related to products/services. In turn, the firm's response to customer-based opportunities will concentrate on actions related to its products and services. This is still surprising because we might expect agile firms to execute certain actions, e.g., increase production or service capacity to meet customer demand.

6.1.3.3 Customer Response Quality

Our results show that, when conceptualized as moderation, agility alignment is significantly related to customer response quality. Hence, customer sensing capability strengthens the relationship between customer responding capability and the extent to which a firm executes actions that meet or exceed customers' needs. This finding is also supported by

the interesting results from our polynomial regression analysis, where we tested the relationship between agility alignment as matching and customer response quality. Our results show that customer response quality is higher when customer sensing capability and customer responding capability are aligned than when they are non-aligned. Also, customer response quality is higher when sensing and responding values are both high than when they are both low. In terms of independent effects, customer response quality is greatest when 1) customer responding capability is at a medium to high level and 2) customer sensing capability is at a high level. This implies that high customer sensing capability and low-to-middle customer responding capability could be the "next best" option, in terms of customer response quality, after high sensing/high responding.

Surprisingly, customer responding capability does not mediate the relationship between customer sensing capability and customer response quality. This finding corroborates our "matching" finding by showing that effectively sensing customers' needs is critical to producing products and services which meet or exceed customers' needs.

6.1.3.4 Customer Response Speed

Finally, we found that customer responding capability mediates the influence of customer sensing capability on customer response speed. This result provides interesting insight into the sense-respond-action process. Although a firm may sense customer-based opportunities for innovation and competitive action, the firm can only execute those actions as quickly as its responding capabilities allow it. In other words, customer responding capability is key to response speed, even when customer sensing capability is also strong.

6.2 Implications for Research

This study has implications for several areas of research reviewed in Chapter 2: organizational agility, dynamic capabilities, information systems, competitive dynamics, and organizational innovation. We discuss each area in turn in the following sections.

6.2.1 Implications for Organizational Agility Research

Organizational agility is one of several concepts proposed to address the issue of how organizations can effectively navigate and succeed in dynamic environments. Figure 6.2 depicts the convergence and evolution of the organizational agility literature. We see that agility emerges from three research streams: organizational adaptation, manufacturing agility and dynamic capabilities. The adaptation literature investigated how an organization's form, structure and design impacted its ability to adapt to environmental change. Scholars working in the agile manufacturing realm tended to focus on how manufacturing firms reconfigured their products and processes in response to changing environmental conditions. Finally, the dynamic capabilities literature provided us with a broader framework in which we could conceptualize customer agility's role in contemporary firms.

We synthesized these rich streams of literature and identified a number of key characteristics which define organizational agility: 1) agility is a capability which must be developed and nurtured by the firm; 2) agility includes the ability to sense and respond to market opportunities; and 3) agility implies an element of quickness, or speed. This implies that future research should take into account these three factors when conceptualizing and measuring agility.

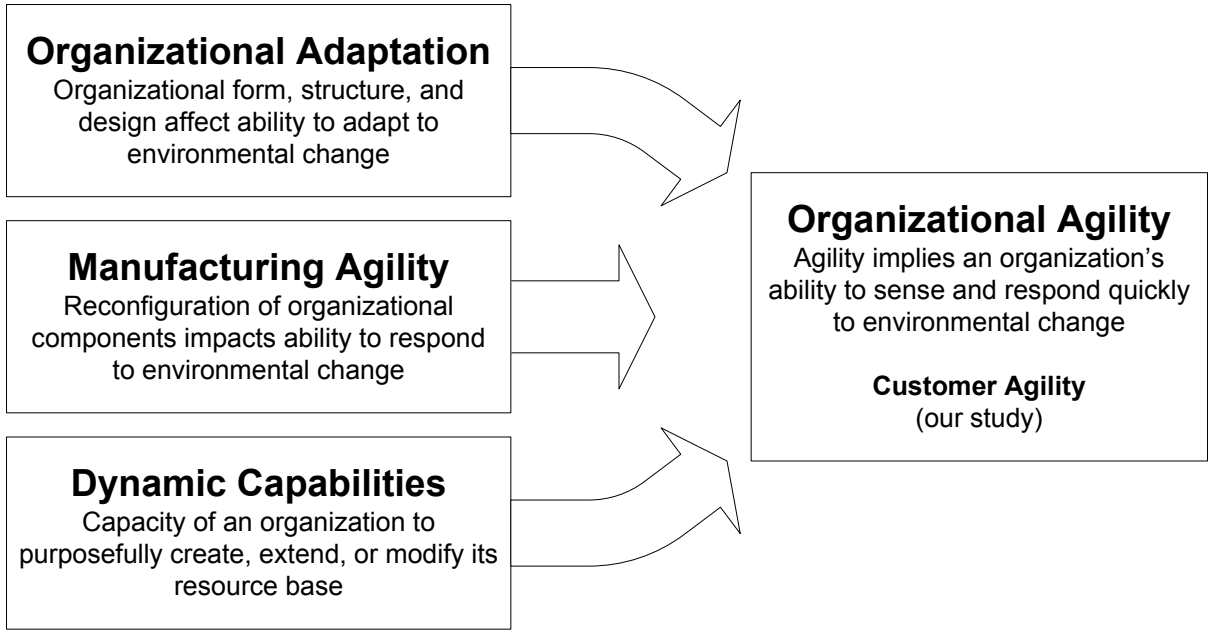


Figure 6.2. Convergence and Evolution of Organizational Agility Literature

Noting that firms may be agile in one or more areas (Overby et al. 2006; Sambamurthy et al. 2003), we focused on customer agility, defined as the degree to which a firm is able to sense and respond quickly to customer-based opportunities for innovation and competitive action. Our literature review and resulting definition sharpens our understanding of organizational agility, particularly customer agility. This definition also allowed us to 1) distinguish customer agility from related concepts and 2) conceptualize different ways in which the sensing and responding components relate to each other. We discuss these two points in the following sections.

6.2.1.1 What Customer Agility is Not

We furthered our understanding of customer agility by distinguishing it from related concepts. Specifically, we noted that customer agility overlaps with absorptive capacity, exploration/exploitation, and market orientation. Prior conceptual work derived agility from the exploration/exploitation literature (Sambamurthy et al. 2003); thus, the boundaries between customer agility and exploration/exploitation were ambiguous. Scholars may also question how customer agility contributes above and beyond existing market orientation literature, the latter being a well-developed stream of research (Cano et al. 2004). We sought to rectify any misunderstandings and clarify how customer agility contributes to our understanding of organizational phenomena.

While customer agility's sensing component is similar to the notion of knowledge absorption, i.e., absorptive capacity, researchers should note that agile firms are able to sense *and* respond to customer-based opportunities. Thus, while a firm may be able to effectively absorb customer-related knowledge, thereby increasing its sensing capability, this does not

necessarily mean that the firm is also able to respond to those sensed opportunities. This also implies that customer agility is *action-focused*, i.e., how does a firm react to external events, while absorptive capacity can be characterized as a "trait" which a firm possesses at any single point in time.

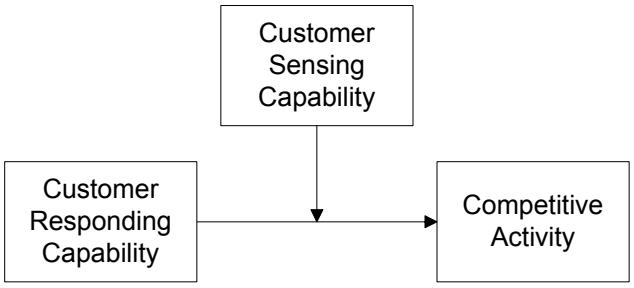
Although prior research built on the notion of exploration/exploitation to define agility (Sambamurthy et al. 2003), our study drew a clearer line between these two concepts. We noted that the interplay between exploration and exploitation occurs in the form of a zero-sum game, thereby making the two incompatible. However, firms must be able to effectively sense *and* respond if they wish to be agile. This implies that sensing and responding are not incompatible; in fact, firms must sense and respond well if they hope to survive in hypercompetitive environments (Haeckel 1999). Although firms often temporally cycle between long periods of exploitation and short bursts of exploitation (i.e., punctuated equilibrium) (Tushman and Anderson 1986), our literature review and discussion shows that cycles between sense and respond activities tend to be much shorter in duration. This is also in line with the action-focused approach to customer agility. Firms must sense and respond quickly if they wish to take advantage of fleeting market opportunities.

Finally, we also distinguished customer agility from market orientation. Our discussion revealed that customer agility is not as reliant on the information process mechanisms underpinning market orientation. Furthermore, market orientation has also been conceptualized as an organizational culture devoted to meeting customers' needs and preferences. Customer agility is an organizational capability, a distinction which sets it apart from the culture perspective of market orientation. Our study also contributes to the emerging

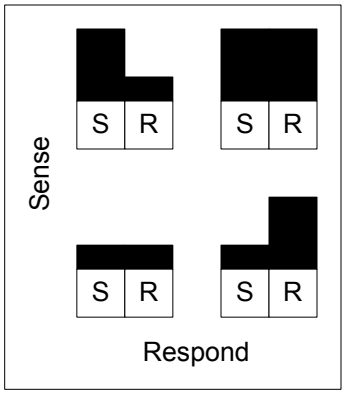
research on sense and respond in the marketing field. While marketing scholars have started investigating how firms sense and respond to their customers (Homburg et al. 2007; Jayachandran et al. 2004), to the best of our knowledge no study conceptualizes and empirically tests a model with antecedents and consequences of customer agility. Thus, we move beyond "culture" and "information processing" aspects of market orientation to a dynamic, capability-driven approach to how firms sense and respond to shifting customer needs and preferences.

6.2.1.2 The Relationship Between Sensing and Responding

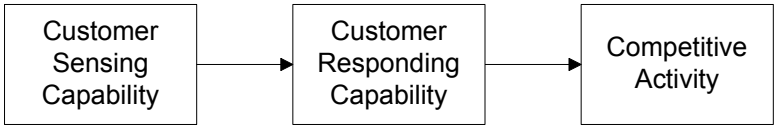
Scholars contend that sensing and responding capabilities need to be simultaneously developed and applied in order for firms to harvest the benefits of agility (Haeckel 1999; Overby et al. 2006). However, no work has conducted a comprehensive investigation of the ways in which sensing and responding can or should be aligned. We took into account three types of agility alignment: moderation, matching and mediation (see Figure 6.3). We then conceptualized the relationship between agility alignment and four types of competitive activity: action volume, action repertoire complexity, customer response quality, and customer response speed.



Agility Alignment as Moderation



Agility Alignment as Matching



Agility Alignment as Mediation

Figure 6.3. Three Views of Customer Agility Alignment

It is important to note that we did not posit a relationship between certain types of agility alignment and certain measures of competitive activity. For example, we argued that a higher "match" between sensing and responding capabilities would not be related to action volume. Following prior recommendations (Venkatraman 1989b), we justified our specification of alignment within our particular research context. Hence, researchers should justify their

alignment specifications and avoid executing convenient statistical methods that might result in misleading research results.

By taking into account multiple perspectives of agility alignment, our empirical results are richer than if we had simply adhered to one perspective of alignment. Our results show that agility alignment as moderation is not related to action volume. In particular, customer sensing capability does not moderate the relationship between customer responding capability and action volume. This implies that competitive activity takes place regardless of a firm's customer sensing capabilities. However, our results do show that agility alignment as mediation is related to action volume. Although a firm may have a strong sensing capability, this implies that the firm must also have a minimum ability to respond in order to take action. To summarize, alignment as moderation is not related to the quantity of actions executed; however, alignment as mediation is related to quantity of actions.

A higher "match" on sensing and responding results in higher quality of customer-based actions; furthermore, if there is an imbalance between sensing and responding, firms with high sense/moderate response capabilities execute higher quality actions (relative to moderate sense/high response). This implication is reinforced by our finding that responding does not mediate the relationship between sensing and customer response quality. In other words, customer sensing capability has a strong effect on customer response quality.

Finally, we found that agility alignment as mediation is related to customer response speed. Specifically, customer responding capability mediates the influence of customer sensing capability on customer response speed. Although a firm may sense customer-based market opportunities, it can only execute those actions as quickly as its responding capabilities allow it.

In other words, customer responding capability is critical to response speed, even when customer sensing capability is also strong.

In summary, our study implies that researchers should take into account multiple perspectives of agility alignment when investigating agility-related phenomena. This is especially important when researchers take into account multiple outcomes of customer agility.

6.2.2 Implications for Dynamic Capabilities Research

Although the dynamic capabilities literature has grown exponentially in the past decade, it contains contradictions, inconsistencies, and a lack of empirical findings (Easterby-Smith et al. 2009). We provide empirical support for the role of dynamic capabilities in facilitating firms' competitive activity in turbulent environments. Specifically, we find that customer agility is an identifiable and measurable dynamic capability that contributes to a firm's competitive activity. Recognizing that dynamic capabilities are context-dependent (Eisenhardt and Martin 2000), we undertake our study in the context of high tech firms competing in turbulent environments. Doing so allows us to further distinguish customer agility as a dynamic capability, as opposed to substantive capabilities and ad-hoc problem solving.

Our study is also one of the first to conceptualize and test a relationship between a dynamic capability (customer agility) and competitive activity. Much of the existing dynamic capabilities literature posits a relationship between dynamic capabilities and firm performance (Easterby-Smith et al. 2009). However, scholars argue that definitions of dynamic capabilities that include effectiveness or performance imply a tautological relationship (Zahra et al. 2006). For example, Vasolo and Anand (2008) contend that a dynamic alliance capability is an organizational ability to choose good and reliable partners and to structure relationships with

partners in a manner that improves performance. Yet this definition infers that if performance is not superior, the firm does not possess a dynamic alliance capability. By examining the link between customer agility and competitive activity, we avoid the dynamic capability-performance tautology pitfall and identify a valuable, tangible outcome of dynamic capabilities. Furthermore, our longitudinal research design bolsters are argument for causality between customer agility and competitive activity.

We also conceptualize customer agility as two fundamental components: customer sensing capability and customer responding capability. Moreover, sensing and responding are enhanced by distinct antecedents: knowledge-based micro-foundations and process-based micro-foundations, respectively. Our study provides fresh empirical support to the nascent knowledge-sense/process-response framework (Teece 2007) and extant practitioner-based research (Haeckel 1999). As a result, this study contributes both theoretically and empirically to the burgeoning dynamic capabilities research stream.

6.2.3 Implications for Information Systems Research

Figure 6.4 places our study in the broader IT business value nomological network. The dominant paradigm in IT business value posits that IT resources combine with complementary organizational assets to create business value (Kohli and Grover 2008). Our study extends this view in a number of ways. First, we note that firms adopt and implement mostly undifferentiated IT resources, e.g., web-based infrastructure. We also take into account various IT capabilities, e.g., analytical ability, that interact with complementary resources to facilitate intermediate IT value (customer agility). Specifically, we conceptualize and measure the

"knowledge creating" synergy and "process enhancing" synergy created by the intersection of particular IT capabilities and organizational factors.

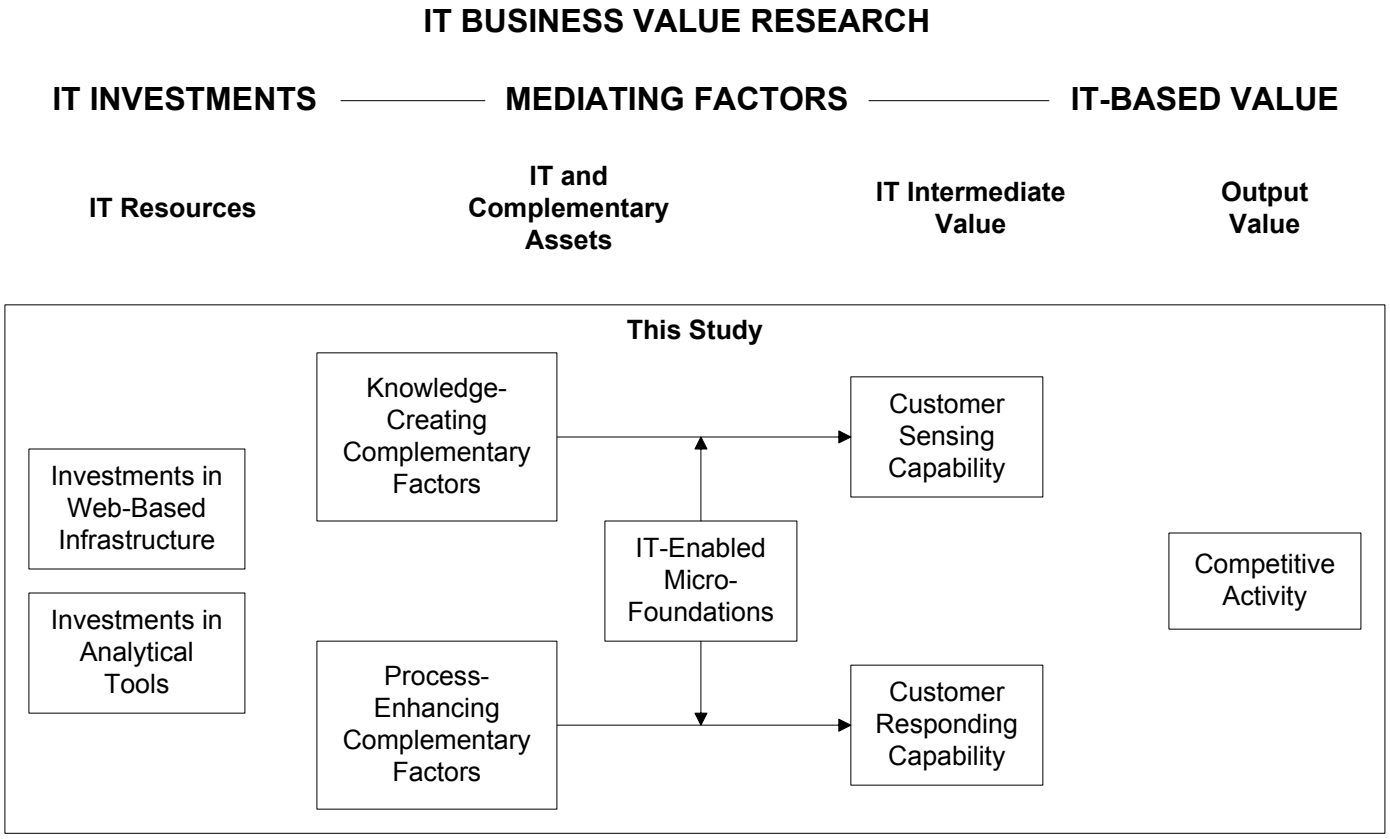


Figure 6.4. Positioning Our Study Within IT Business Value Research

However, we also depart from the dominant IT business value paradigm in a number of important ways. For example, while prior research often investigates how IT impacts a firm's competitive advantage or performance, ours is the first study to empirically examine how IT enhances a firm's customer agility. In turn, customer agility positively impacts a firm's competitive activity; specifically, customer response quality and customer response speed. Hence, while prior research has focused on direct economic benefits, we expand our understanding of IT business value to alternative outcomes of intangible value (customer agility) and tangible value (competitive activity).

Another departure from prior research is our positioning of IT as both driver and magnifier. In doing so we provide further insight into the form and function of IT assets and IT capabilities. An asset is anything tangible or intangible that the firm owns, controls, or has access to on a semi-permanent basis (Helfat and Peteraf 2003). An organizational capability is a high-level routine or set of routines that confers a set of decision options upon an organization's management for producing significant outputs of a particular type (Winter 2003). In other words, a capability is something a firm does well or does poorly.

Existing IT business value research often conceptualizes the IT value sequence as the following – IT assets enhance organizational capabilities, which in turn create business value (Kohli and Grover 2008). We follow this line of research by testing the link between web-based infrastructure (IT asset) and customer sensing capability (organizational capability). However, we also expand our view by conceptualizing and testing IT as a magnifier or positive moderator of organizational capabilities which, in turn, create value. Specifically, we position internal IS integration and external IS integration as magnifiers of two alternative capabilities, namely,

interfunctional coordination and channel coordination, respectively. The synergies arising from these interactive effects enhance the firm's customer responding capability. Our positioning of analytical ability as moderator follows this same line of thought.

Investigating IT as both driver and magnifier provides insight into the nature and positioning of IT assets and IT capabilities. Figure 6.5 depicts a portion of our research model to illustrate these relationships. As a driver, IT is an asset which enhances an organization's ability to sense customer-based opportunities. This finding provides support for existing perspectives on how organizations build capabilities (Makadok 2001; Sirmon et al. 2007). When conceptualized as a magnifier, IT is a capability which creates synergies with complementary organizational capabilities that, in turn, facilitate an organization's ability to respond to customer-based opportunities. This finding furthers our understanding of how IT capabilities complement other organizational capabilities to create business value (Bharadwaj et al. 2007; Tanriverdi 2006). Our conceptualization of IT as both driver and magnifier provides two competing yet complementary perspectives on how IT creates business value.

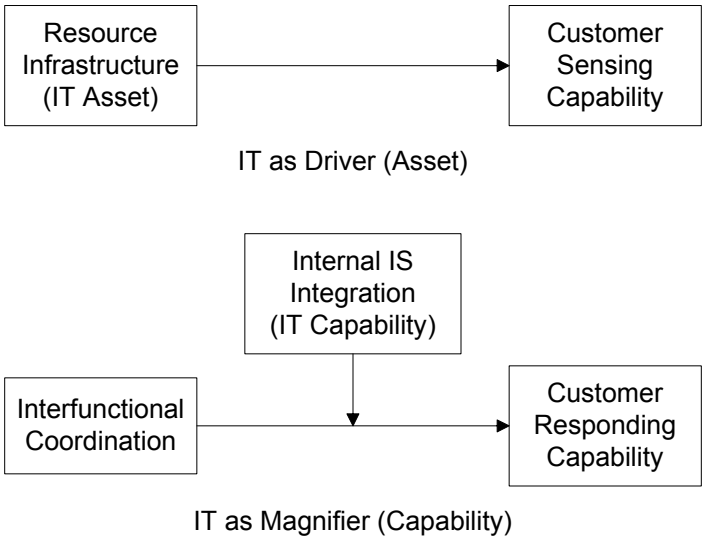


Figure 6.5. IT as Driver (Asset) and Magnifier (Capability)

6.2.4 Implications for Competitive Dynamics Research

The competitive dynamics literature has leveraged the awareness-motivation-capability framework to investigate numerous factors explaining why firms undertake actions (Smith et al. 2001). Despite this wealth of literature, no work to date has empirically investigated the relationship between agility and competitive activity. Our study contributes to competitive dynamics research by conceptualizing and testing the relationship between customer agility and competitive activity outcomes. Furthermore, much of the prior empirical work on competitive dynamics investigates the relationship between descriptive organizational characteristics (e.g., firm size, top management team heterogeneity, organizational slack) and competitive activity (Smith et al. 2001). Our results imply that researchers should move beyond a static, "organizational characteristics-activity" link to more of a dynamic, "capability-activity" relationship. In fact, our synthesis of the dynamic capabilities framework with competitive dynamics is one step in this direction.

We linked customer agility to four types of competitive activity, two of which are well-established in the competitive dynamics literature: action volume and action repertoire complexity. While scholars have investigated numerous antecedents to action volume, less attention has been paid to causes of action repertoire complexity. Researchers find that action repertoire complexity impacts firm performance (Ferrier et al. 1999) and firm reputation (Basdeo et al. 2006). Our results show that customer agility is not related to action repertoire complexity. These findings imply that the established ability-motivation-awareness framework may not readily apply to action repertoire complexity.

Competitive dynamics research has been criticized for assuming that firms operating in the same industry segment provide similar or substitutable offerings to customers (Markman et al. 2009). In other words, competitive dynamics researchers tend to focus on the quantity or repertoire of actions a firm undertakes (Ketchen et al. 2004), as opposed to the quality or efficacy of actions. Our study takes an initial step toward an understanding of the factors that allow a firm to execute the right action at the right time. We conceptualized and validated customer response quality, defined as the extent to which a firm executes actions which meet customer needs in a given time period. In doing so we gain a better understanding of how a firm's customer agility can impact the extent to which its competitive actions meet or address customer needs, as well as how quickly firms can execute such actions. We believe that investigating how a firm executes effective actions in the marketplace will provide deeper understanding into research on competitive dynamics and firm rivalry.

We also conceptualized and measured customer response speed, a construct which captures the rate at which a firm responds to customer-based market opportunities. Response

speed is critical to firm success, especially in hypercompetitive environments (D'Aveni 1994). However, while prior research often examines how fast firms respond to competitors' actions (Smith et al. 2001), it is also important that firms react quickly to shifts in customers' preferences before they lose those customers to competitors. Our results provide interesting implications. We found that customer responding capability mediates the relationship between customer sensing capability and customer response speed. Thus, while a firm may excel at sensing customer-based opportunities, it must have a well-honed responding capability in place if it wishes to respond quickly to those opportunities.

6.2.5 Implications for Organizational Innovation Research

Our study also has several implications for organizational innovation research. Scholars note that firms are increasingly moving toward open models of innovation in which they combine external ideas with internal ideas to foster innovative products and processes (Chesbrough 2003; Nambisan and Sawhney 2008). There are numerous external sources of innovation and ideas, one of which is a firm's customers. Despite the promise of open innovation, empirical research on its impacts is hard find. Our study helps fill this gap by describing how the interplay between customers and IT contributes to a firm's ability to sense market opportunities for innovation.

Drawing on prior conceptual work (Nambisan 2002), we theorize that customers can perform three roles in new product development (NPD) processes: resource, cocreator and user. Traditionally, it has been quite difficult for firms to engage customers in these roles, primarily owing to the high connectivity barriers between firms and customers. However, the Internet provides a platform upon which firms can provide web-based tools that allow

customers to perform various NPD roles. Our results show that the information generated from customers' use of web-based resource and user tools significantly contributes to a firm's ability to sense customer-based opportunities for innovation and competitive action. This supports earlier empirical research (Prandelli et al. 2006) and implies that firm-hosted online communities can provide value to innovative firms. Our results support the facilitating role of IT in engaging the customer in open innovation processes.

6.3 Implications for Managers

Our study has clear implications for managers. First, managers should develop and maintain a repertoire of web-based tools that allow customers to perform a variety of NPD-related roles. In doing so, customers are more likely to offer recommendations on how the firm can improve existing products and services, assist peers in troubleshooting problems, and suggest ideas for new products and services. The extended reach, enhanced interactivity, and greater flexibility provided by web-based tools generate a wealth of information that managers can then leverage to determine customers' expressed and latent needs. As a result, firms are more likely to sense a range of potential market opportunities.

Our results also show that building analytical capabilities is not sufficient. Rather, firms must have data streaming in before they can leverage analytical tools. However, managers who take advantage of the synergies arising from voluminous amounts of web-based data from customers and data mining analytical capabilities will improve their ability to sense customer-based market opportunities in a relevant and timely manner.

Our study finds that coordination is critical to achieving an ability to respond to market opportunities. Managers should cultivate both interfunctional coordination mechanisms and channel coordination processes. By doing so their firm will be better positioned to respond quickly when an opportunity presents itself. Furthermore, integration of a firm's internal information systems speeds the flow of information, thereby magnifying the effect of interfunctional coordination on response ability. An integrated IS also produces a standard, consistent view of information throughout the organization, enhancing interfunctional exchanges and promoting joint understanding.

Finally, our results suggest that managers would do well to align their sensing and responding capabilities. Specifically, while it is important that sensing and responding should be balanced, managers should focus on sensing processes when they desire to create products and services which meet customers' needs and preferences. Without a strong customer sensing capability in place, firms cannot execute effective actions in the marketplace. On the other hand, strong customer response processes are required in order to quickly execute customer-based opportunities for innovation and competitive action.

6.4 Limitations

Our study has several limitations which should be noted. One limitation is the use of the same respondent for both our independent and dependent variables. Statistically, common method bias does not appear to threaten the validity of our results. Furthermore, our longitudinal survey design should have reduced the potential for bias. However, we note that using the same respondent might have upwardly biased our results. Future research should use multiple methods of measurement to alleviate any potential bias.

Our dichotomous measures of web-based infrastructure limited our ability to fully understand how firms develop and leverage firm-hosted online communities to their advantage. Future research should examine how emerging characteristics of online communities – such as content quality, member embeddedness, level of customer interactions, trust in community sponsor (Porter and Donthu 2008) – contribute to a firm's ability to sense customer-based opportunities for innovation and competitive action. Furthermore, linking third-party hosted online communities (Verona et al. 2006) to a firm's customer agility presents an interesting line of inquiry for future research.

While our conceptualization and measure of customer response quality contributes to our understanding of how a firm's customer agility impacts the quality of its actions, we note that there are many factors that go into a firm's decision-making processes with respect to competitive activity (Smith et al. 2001). Determining whether or not a firm executed the right action at the right time is very elusive, if not impossible. Future research could link survey-based measures with market-based measures (e.g. stock market returns, Ferrier and Lee 2002) to gain deeper insight into the quality of competitive activity.

6.5 Suggestions for Future Research

Our study provides a stepping stone for several fruitful areas for future research. For example, while we examined how IT facilitates customer agility in a new product development (NPD) context, work could also be done in non-NPD environments. It would be interesting to investigate how IT enhances a firm's ability to sense and respond to customer-based opportunities in a service-oriented environment. IS scholars have noted the increasingly important role of IT in service management (Rai and Sambamurthy 2006). Furthermore, the

customer often plays a relatively major role in the service experience (Vargo and Lusch 2004). Thus, examining the relationships between IT resources, customer agility, customer roles and behavior, and service management would provide interesting and powerful implications for research and practice.

In a related vein, future research could also investigate how firms can leverage IT to involve customers in the co-production of products. While the promise of mass customization has been noted for quite some time (Pine 1993), obstacles still remain. For example, web-based co-creation tools are not widely diffused across the business landscape (Prandelli et al. 2006). Researchers should undertake case studies to gain deeper insight into the role IT plays in the relationship between customers and firms in a co-production environment.

While this study explored how firms leverage their website to gain valuable information and customer-based knowledge, future research can look at how firms can possibly scan third-party hosted websites to gather relevant customer-based information. Websites such as yet2.com and innocentive.com offer global communities for open innovation, a space in which scientists, professionals and entrepreneurs collaborate to develop solutions to unique problems. These third parties have been termed “virtual knowledge brokers” for their role in connecting knowledge sources to knowledge seekers (Verona et al. 2006). IT certainly plays a role in the broader emerging concept of open innovation.

With respect to customer agility, future research should further explore the relationship between sensing and responding capabilities. This study opens the door to three competing yet complementary perspectives on agility alignment: moderation, matching and mediation. Future research should examine how these three perspectives fare against each other with alternative

outcomes of interest (e.g., firm performance, customer satisfaction). Another interesting route would look at the factors that contribute to agility alignment. What are the factors that help firms align their sensing and responding capabilities? How does IT contribute to agility alignment? These are intriguing questions that should provide powerful implications if addressed.

6.6 Conclusion

We conceptualized and empirically tested a model including IT, complementary organizational factors, customer agility, and competitive activity. In doing so we drew from multiple theoretical perspectives, including dynamic capabilities, capability alignment, competitive dynamics, and the IT business value literature. We tested our model in the context of new product development, where customers can play the role of resource, cocreator and user. Our results showed that IT facilitates a firm's ability to sense and respond to customer-based opportunities for innovation and competitive action. Moreover, we found that customer agility is positively related to a firm's competitive activity. Our study provides greater understanding of how IT creates value for firms competing in hypercompetitive environments.

APPENDIX A: SURVEY ONE

Survey of Information Technology and Customer Agility

CLEMSON UNIVERSITY

This questionnaire is designed to evaluate how information technology facilitates the ways in which organizations sense and respond to their customers' needs and preferences. Our objective is to provide recommendations that will enhance various uses of information technology to support the success of customer-based organizational processes. Results will be provided to all participants on request, and full confidentiality of your responses will be maintained. Furthermore, there are no right or wrong answers.

The ideal respondent for this questionnaire should be a manager who has extensive knowledge of marketing practices and customer relationships in his/her organization. The questionnaire is designed in an easy to read format and should not take more than 10 minutes of your time. We appreciate your participation in this venture.

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Which of the following organizational functions are you currently assigned to?

- Accounting
- Engineering
- Human Resources
- Information Technology
- Marketing
- Production
- Sales

Please use your business unit (e.g., product/customer division) as the reference point to provide your responses about your organization. For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Agree	Strongly Agree
We continuously try to discover additional needs of our customers even before they are aware of them.	1	2	3	4	5	6	7
We work closely with lead users who try to recognize customer needs months or even years before the majority of the market may recognize them.	1	2	3	4	5	6	7
We extrapolate key trends to gain insight into what users in a current market will need in the future.	1	2	3	4	5	6	7
We continuously try to anticipate our customers' needs.	1	2	3	4	5	6	7
We attempt to develop new ways of looking at customers and their needs.	1	2	3	4	5	6	7
We sense our customers' needs even before they may be aware of them.	1	2	3	4	5	6	7
We respond rapidly if something important happens with regard to our customers.	1	2	3	4	5	6	7

We quickly implement our planned activities with regard to customers.	1	2	3	4	5	6	7
We quickly react to fundamental changes with regard to our customers.	1	2	3	4	5	6	7
When we find that customers would like us to modify a product or service, our organization rapidly makes concerted efforts to do so.	1	2	3	4	5	6	7
When we identify a new customer need, we are swift to respond to it.	1	2	3	4	5	6	7
We are fast to respond to changes in our customers' product or service needs.	1	2	3	4	5	6	7
We have IT applications which offer various decision-making tools (such as optimization, scenario analysis, etc.) that we use for managing our relationships with customers.	1	2	3	4	5	6	7
We have IT applications which offer various simulation and what-if analysis tools that we use for managing our relationships with customers.	1	2	3	4	5	6	7
We have IT applications which offer various tools that enable us to examine trends in the data for supporting our interactions with customers.	1	2	3	4	5	6	7
We have IT applications which offer various statistical tools that enable us to support our interactions with customers.	1	2	3	4	5	6	7

For each of the statements below, please indicate whether or not the feature is available on your company's web site by checking the appropriate box.

A "Contact Us" hyperlink or form	Yes	No
Feedback surveys	Yes	No
Chat rooms	Yes	No
Tools that allow customers to chat with company representatives	Yes	No
Suggestion boxes or forms	Yes	No
Opinion polls	Yes	No
Blogs (i.e., web pages maintained by a company representative with regular entries of commentary or descriptions of events)	Yes	No
Web pages that provide product extensions or add-ons	Yes	No
Design tools that enable users to manipulate aesthetic features of a product or service (i.e., how a product looks or feels)	Yes	No
Design tools that enable users to manipulate functional features of a product or service (i.e., how a product works or functions)	Yes	No
User reviews of products or services	Yes	No
Product testing tools	Yes	No
Web pages that provide early releases of products (e.g., beta versions)	Yes	No
Wikis (i.e., web pages designed to allow users to contribute or modify content)	Yes	No
Directories that allow users to locate experts in a particular area	Yes	No
Bulletin boards (i.e., forums)	Yes	No

Please use your business unit (e.g., product/customer division) as the reference point to provide your responses about your organization. For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Agree	Strongly Agree
The activities of functional units are tightly coordinated to ensure better use of our market knowledge.	1	2	3	4	5	6	7
Functions such as R&D, marketing, and manufacturing are tightly integrated in cross-functional teams in product development processes.	1	2	3	4	5	6	7
Functional units regularly share market information about customers, technologies, and competitors.	1	2	3	4	5	6	7
There is a high level of cooperation and coordination among functional units in setting the goals and priorities for the organization to ensure effective response to market conditions.	1	2	3	4	5	6	7
Top management promotes communication and cooperation among functional units in market information acquisition and use.	1	2	3	4	5	6	7
Our information systems allow us integrated access to all customer-related data (e.g., service contracts, feedback).	1	2	3	4	5	6	7
Our information systems allow us integrated access to all order-related data (e.g., order status, handling requirements).	1	2	3	4	5	6	7
Our information systems allow us integrated access to all production-related data (e.g., resource availability, quality).	1	2	3	4	5	6	7
Our information systems allow us integrated access to all market-related data (e.g., promotion details, future forecasts).	1	2	3	4	5	6	7

Please indicate the extent to which you agree or disagree with the following statements describing your business unit's ties with its large channel partners (contract manufacturers, suppliers, subcontractors) only.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Agree	Strongly Agree
To facilitate operations, our organization's business procedures and routines are linked with the business procedures and routines of our channel partners.	1	2	3	4	5	6	7
Our way of doing business is closely linked with our channel partners.	1	2	3	4	5	6	7
The business procedures and routines of our business unit are highly coupled with the business procedures and routines of our channel partners.	1	2	3	4	5	6	7
Some of our operations are closely connected with the operations of our channel partners.	1	2	3	4	5	6	7
To operate efficiently, we rely on procedures and routines of our channel partners.	1	2	3	4	5	6	7
Data are entered only once to be retrieved by most applications of our channel partners.	1	2	3	4	5	6	7
We can easily share our data with our channel partners.	1	2	3	4	5	6	7
We have successfully integrated most of our software applications with the systems of our channel partners.	1	2	3	4	5	6	7
Most of our software applications work seamlessly across our channel partners.	1	2	3	4	5	6	7

For each of the statements below, please indicate how much you agree or disagree by selecting the appropriate response.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Agree	Strongly Agree
It is sometimes hard for me to go on with my work if I am not encouraged.	1	2	3	4	5	6	7
I sometimes feel resentful when I don't get my way.	1	2	3	4	5	6	7
On a few occasions, I have given up doing something because I thought too little of my ability.	1	2	3	4	5	6	7
There have been times when I felt like rebelling against people in authority even though I knew they were right.	1	2	3	4	5	6	7
I am sometimes irritated by people who ask favors of me.	1	2	3	4	5	6	7

1. Approximately how many people work in your organization?
2. In what year did your organization make its first sale?
3. Please indicate your organization's primary industry category:
    a. Computer Manufacturing
    b. Construction
    c. Education
    d. Electric, Gas, Water
    e. Finance, Insurance, Real Estate
    f. Manufacturing (not computer)
    g. Prepackaged Software
    h. Retail Trade
    i. Transportation
    j. Wholesale Trade (Distribution)
    k. Other, please specify

4. What is the highest level of education you have completed?
    a. High School
    b. Some College
    c. College Degree
    d. Graduate Degree
5. How many years have you been with this organization?
6. How many years have you been in your current position?
7. How active are you currently in formulation of managerial policies of your organization?
    a. Not very active
    b. Moderately active
    c. Very active
8. How active are you currently in formulation of marketing/sales policies of your organization?
    a. Not very active
    b. Moderately active
    c. Very active
9. What is your job title?
10. How old were you on your last birthday?
11. What is your gender?
    a. Male
    b. Female

APPENDIX B: SURVEY TWO

Survey of Information Technology and Customer Agility

CLEMSON UNIVERSITY

This questionnaire is the second of two designed to evaluate how information technology facilitates the ways in which organizations sense and respond to their customers' needs and preferences. Our objective is to provide recommendations that will enhance various uses of information technology to support the success of customer-based organizational processes. Results will be provided to all participants on request, and full confidentiality of your responses will be maintained. Furthermore, there are no right or wrong answers. The questionnaire is designed in an easy to read format and should not take more than 10 minutes of your time. We appreciate your participation in this venture.

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Are you working for the same organization that employed you in October 2008?

- Yes
- No

Please use your business unit (e.g., product/customer division) **that employed you in October 2008** (whether you still work there or not) as the reference point to provide your responses about your organization.

The purpose of this section is to discover what **major actions** your organization took between January 1, 2008, and December 31, 2008, **in response to customer feedback, input or suggestions**. By major actions we refer to externally directed, specific, observable activity initiated by your organization. These actions are often announced in press releases and/or news articles. For example, the launch of a new product would constitute a major action. The creation of a new joint venture with another organization would also constitute an action. However, frequent adjustments in pricing (on a daily, weekly or other recurring basis) **would not** constitute major actions.

Please estimate the **number of major actions** your company executed in the following categories. Based on customer feedback, input or suggestions, we executed…

New pricing actions (e.g., major price increases, discounts, rebates	0	1	2	3	4	5	6	7	8	9	10	> 10
New marketing actions (e.g., rewards, promotions, marketing campaigns)	0	1	2	3	4	5	6	7	8	9	10	> 10
New product actions (e.g., new product/service launch, roll out, release)	0	1	2	3	4	5	6	7	8	9	10	> 10
New capacity actions (e.g., changes in capacity or output of products or services)	0	1	2	3	4	5	6	7	8	9	10	> 10
New alliance actions (e.g., new joint venture, alliance, distribution agreement)	0	1	2	3	4	5	6	7	8	9	10	> 10

Please estimate what percentage of major actions your organization took in 2008 **in response to customer feedback, input or suggestions** that, based on your organization's assessment, met or addressed customer needs.

Pricing actions	< 10%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%
Marketing actions	< 10%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%
Product actions	< 10%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%
Capacity actions	< 10%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%
Alliance actions	< 10%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%

Please keep in mind the major actions your organization took between January 1, 2008, and December 31, 2008, in response to customer feedback, input or suggestions. For each of the statements below, please indicate how much you agree or disagree with each by selecting the appropriate response.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Agree	Strongly Agree
We took quick action when something important happened with regard to our customers.	1	2	3	4	5	6	7
We quickly implemented our planned activities with regard to customers.	1	2	3	4	5	6	7
When we identified a new customer need, we were swift to execute the appropriate action.	1	2	3	4	5	6	7
We were fast to take action in response to changes in our customers' product or service needs.	1	2	3	4	5	6	7

Among the actions your business unit took in 2008, think of ONE in particular that stood out as being the most successful.

Please briefly describe this action:

Please briefly describe the basis or criterion on which you decided to execute this action:

Please briefly describe what your business unit had to do to successfully implement this action:

Please briefly describe how you evaluated whether this action was successful:

If applicable, please briefly describe how your organization used information technology during this process (e.g., we collected customer data through our web site, we used software to analyze customer data):

This section assesses the extent to which the recent economic downturn has impacted your organization. For each of the statements below, please indicate how much you agree or disagree with each by selecting the appropriate response. Over the past six months…

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree Nor Disagree	Somewhat Agree	Agree	Strongly Agree
We have seen substantial loss of sales.	1	2	3	4	5	6	7
We have experienced significant reductions in our customer base.	1	2	3	4	5	6	7
We have cancelled contracts with suppliers.	1	2	3	4	5	6	7
We have reduced our employee base.	1	2	3	4	5	6	7
We have seen budget cuts.	1	2	3	4	5	6	7

How old were you on your last birthday?

APPENDIX C: FIRMS AND WEBSITES ASSESSED IN WEB INFRASTRUCTURE PRETEST

Company Name*	Web Address*
Adobe Systems Inc	www.adobe.com
Ariba Inc**	www.ariba.com
Borland Software Corp	www.borland.com
Compuware Corp**	www.compuware.com
Dell Inc	www.dell.com
Electronic Arts Inc	www.ea.com
Gerber Scientific Inc**	www.gerberscientific.com
Hewlett-Packard Co	www.hp.com
KANA Software Inc**	www.kana.com
Midway Games Inc	www.midway.com
Motorola Inc	www.motorola.com
NCR**	www.ncr.com
Netopia Inc**	www.netopia.com
Novell Inc	www.novell.com
Oracle Corp	www.oracle.com
Palm Inc	www.palm.com
Phoenix Technologies Ltd**	www.phoenix.com
Realnetworks	www.real.com
Red Hat Inc	www.red-hat.com
SPSS Inc	www.spss.com
Sun Microsystems Inc	www.sun.com
Symantec Corp	www.symantec.com
Tektronix Texas LLC**	www.tek.com
Thomson Corp**	www.thomson.com
Unisys Corp**	www.unisys.com
*Data for firms and web site addresses were collected from Dun & Bradstreet's Million Dollar Database. Consistent with our target sample frame, these public firms are listed under SIC Industry Groups 3571 or 7372. ** These firms primarily serve business customers, not consumers. As a result, they were excluded from further analysis.	

APPENDIX D: RESULTS OF WEB INFRASTRUCTURE PRETEST

• = tool is present

Company Name	"Contact the Firm" Option	Feedback Survey	Suggestion Box	Online Polls	Weblogs	Product Extensions	Aesthetic Design Toolkit	Functional Design Toolkit	User Reviews	Product Testing	Wikis	Knowledge Yellow Pages	Customer Forums	Total Number of Tools
Adobe Systems Inc	•	•	•		•	•		•	•	•	•	•	•	11
Borland Software Corp	•		•			•				•			•	5
Dell Inc	•	•	•		•	•	•	•	•	•		•	•	12
Electronic Arts Inc	•	•	•	•	•	•	•	•	•	•	•	•	•	14
Hewlett-Packard Co	•	•	•			•	•	•	•	•			•	9
Midway Games Inc	•	•	•										•	4
Motorola Inc	•	•	•			•								4
Novell Inc	•	•	•	•	•	•		•		•	•		•	10
Oracle Corp	•				•	•		•	•	•	•	•	•	10
Palm Inc	•	•			•		•	•					•	7
Realnetworks Inc	•	•	•	•	•				•				•	7
Red Hat Inc	•							•					•	3
SPSS Inc	•	•	•			•		•		•	•	•	•	10
Sun Microsystems Inc	•	•	•	•	•	•		•		•	•	•	•	12
Symantec Corp	•	•	•			•		•		•			•	8
Total Number of Firms with Tool Present	15	14	12	4	8	11	4	11	6	10	6	6	14	

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