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The Role of Information Technology in Firm Agility: An Electronic Integration Perspective

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ABSTRACT

Organizational agility, defined as the ability of organizations to sense and respond to market opportunities and threats with speed and surprise, is quickly becoming the hallmark of companies that consistently emerge as leaders in hypercompetitive environments. While explaining the role of IT, this paper argues that in order to be agile firms must be electronically integrated internally (with organizational units) and externally (with partners, suppliers and customers). Such integration enables firms to capitalize on knowledge and competencies of their partners and allows them to be agile in sensing and responding to opportunities and threats. This paper uses the organizational integration model presented by Barki and Pinsonneault (2005) and focuses primarily on the role of IS in organizational integration. While exploring this relationship and the mediating effects of knowledge integration and core business process competencies, this paper contributes a complementary view of organizational agility.

Keywords

Electronic Integration, Firm Agility, Knowledge Integration, Core Competence, Sensing, Responding.

INTRODUCTION

Agility is the ability of firms to sense opportunities and threats and respond to them with speed and surprise (Dove, 2001; Overby, Bharadwaj and Sambamurthy, 2006; Sambamurthy, Bharadwaj and Grover, 2003). In a business environment which is becoming increasingly hypercompetitive (Goldman, Nagel and Preiss, 1995) firms need to be on a continuous lookout for innovative ways to reconceptualize and reconfigure their products and services in order to provide customers with value and match opportunities and threats with speed (D'Aveni, 1994; Goldman et al., 1995). The role of IT in creating digital platforms for agility therefore becomes of critical import to academics and practitioners.

The IS literature has touched upon interesting concepts regarding the antecedents of agility, such as knowledge richness and reach, process richness and reach, or simply, digital options (e.g. Overby et al., 2006; Sambamurthy et al., 2003). While research has explored the digital options to agility link, a clear understanding of how IT provides digital options that lead to sensing and responding is lacking. This paper argues that it is, in fact, the level of integration that a firm possesses internally and with its value chain (comprising of its customers, suppliers, distributors and partners) that enables sensing and responding to environmental changes. Firms such as Dell, Kodak, and Cisco Systems have remained agile primarily by achieving close integration with their customers, suppliers, and partners (e.g. Rai, Patnayakuni and Seth, 2006). For instance, integrating with customers and suppliers has allowed Dell to sense its customers' needs and respond to these needs by close collaboration with suppliers. Integration, therefore, affords a blurring of organizational boundaries and gives firms the ability to capitalize on knowledge and core competencies of their value-chain, and in turn, sense and respond to opportunities and threats in the market (e.g. Magretta, 1998; Youssef, 1992). The key notion behind this argument is that integration allows organizational components to be responsive and flexible to each other as well as the environment through sharing of knowledge and expertise while keeping their individual distinctiveness.

Drawing insights from organizational integration and supply chain literatures, this paper argues that electronic integration leads to firm sensing and responding agility through the mediating effects of internal and external knowledge integration and

integrity and functionality-related core competencies of the firm. The next section presents a literature review. Section 3 presents the conceptual model. Finally, the contributions and conclusions of the paper are presented.

THEORETICAL BACKGROUND

The IS literature on firm agility conceptualizes digital options, a key enabler of firm agility, as composed of knowledge richness and reach and process richness and reach (Overby et al., 2006; Sambamurthy et al., 2003). However, the literature does not effectively explain the role of IT in creating digital options. The role of IT in enabling digital options could be interpreted as many things, ranging from technical and managerial IT skills (Mata, Fuerst and Barney, 1995) to reusable technology base (Ross, Beath and Vitale, 1996) to complementary IT - business resources and the like (e.g. Bharadwaj, 2000). It is, therefore, unclear which aspect of IT enables firm agility.

Research alludes to one particular enabling role of IT, that of *electronic integration* on agility, but this role has primarily remained unanalyzed in IS literature. For instance, while identifying specific infrastructural capabilities related to strategic agility, Weill, Subramani and Broadbent (2002) argue that integration of the IT infrastructure is a key capability; however, the authors do not attempt to study its role on agility. Similarly, in their conceptual work, Overby et al. (2006) argue that integration allows firms to adjust quickly to changing environments and hence plays a significant role in organizational agility. However, the authors do not develop this argument any further. Hence, research has stressed the importance of IT infrastructure that enables streamlining of business processes but none has explored the relationship between integration through IT and organizational agility.

While offering a complementary understanding, this paper attempts to develop a conceptual model of the role of IT in enabling agility by drawing on the notion of organizational integration as proposed by Barki and Pinsonneault (2005). Following the Organizational Integration model (Barki and Pinsonneault, 2005), this paper argues that different types of electronic integration lead to different dimensions of agility and that these are mediated by knowledge integration and core business processes constructs (see Figure 1).

THEORETICAL FRAMEWORK

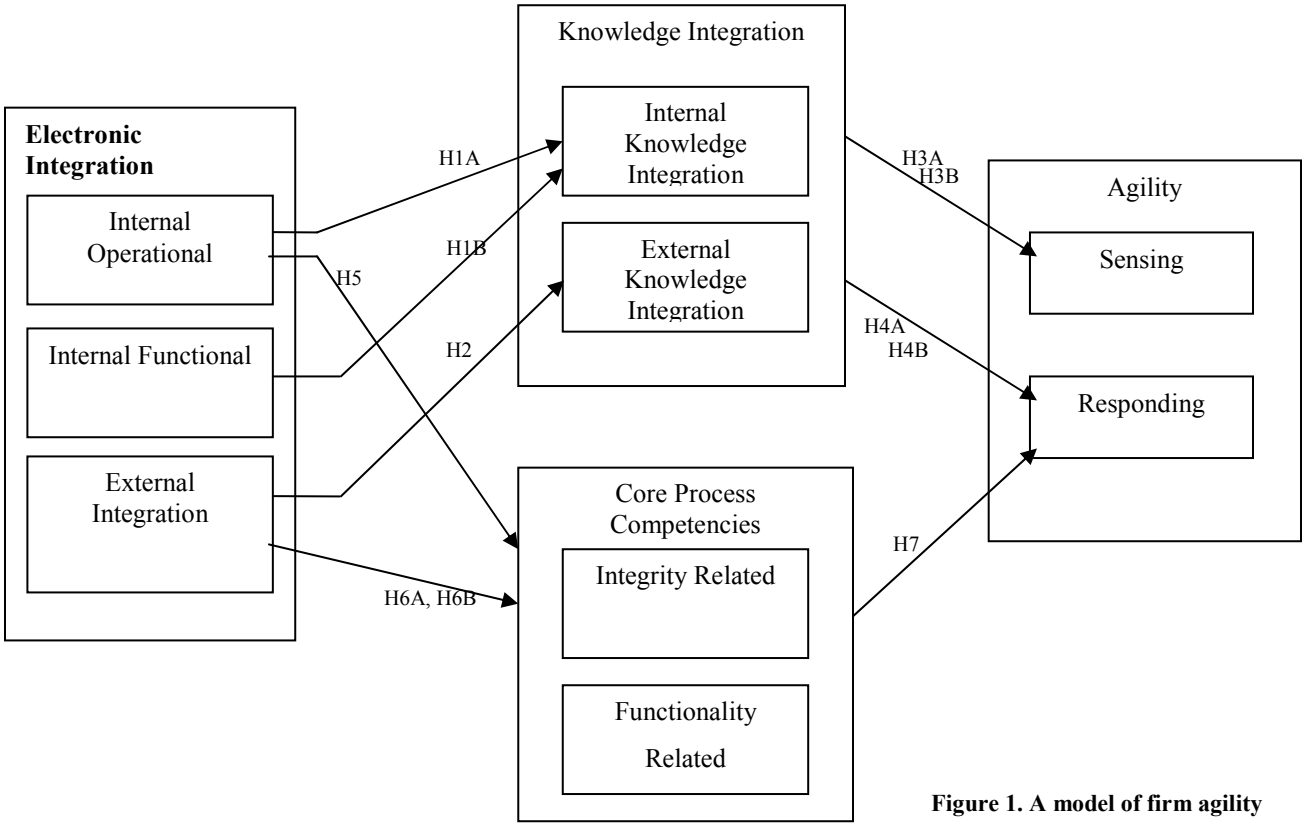

Figure 1. A model of firm agility

Agility in general can be defined as the quality or capability to move quickly (Lyytinen and Rose, 2006). In an organizational context, agility can be defined as the ability of firms to sense and respond swiftly to changes (opportunities and threats) in their environment. *Sensing* is the ability to track competitors' actions, consumer preference changes, as well as technological advancements (Overby et al., 2006). *Responding* is the ability to take advantage of favorable changes or protect oneself from negative changes by adjusting one's course of action. This could involve the ability to develop new products, create new distribution channels or target new customer bases (Overby et al. 2006). This paper argues that electronic integration has a significant enabling effect on sensing and responding agility through knowledge integration; and also that electronic integration plays a significant role in responding agility though core process competencies.

Electronic Integration and Knowledge Integration

Electronic Integration

Research conceptualizes integration as the extent to which business processes of organizations are standardized and tightly coupled through IT infrastructure (Barki and Pinsonneault, 2005; Malone et al., 1999). Consistent with this perspective, electronic integration (EI) is characterized with two elements. The **distinctiveness** of components is due to specialization of knowledge and skills. In addition to being distinct, these organizational components also need to be **responsive** to each other in order for an organization to capitalize on the diversity of skills of the different components. Our definition of integration is consistent with this perspective and follows the organizational integration model proposed by Barki and Pinsonneault (2005). However, an important point of departure is that this paper does not stress tight coupling of systems. The focus of this paper is primarily on responsiveness of actors (customers, partners, suppliers, organizational units) to each other while remaining distinctive and loosely coupled. We define electronic integration as *the extent to which business processes of organizations are standardized and responsive through IT infrastructure.*

Organizational processes can be distinguished into two types, those that are internal and those that are external to the organization. These processes can be subdivided as primary processes that *contribute directly* to organizational outputs (operational processes, e.g. manufacturing), and secondary processes that *support* the primary activities (functional processes, e.g. sales). Based on these distinctions four types of integration from the OI model (Barki and Pinsonneault, 2005) are deemed relevant to this paper. (1) **Internal-operational EI** is the integration of the primary activities of an organization; (2) **internal-functional EI** is the integration of the secondary activities of an organization; (3) **external-operational-forward** is the integration of the primary activities of an organization into distribution and sales; and (4) **external-operational-backward** is the integration of the primary activities of an organization into supply. Since external-operational-forward and external-operational-backward both relate to integration of operational activities with outside partners, this paper uses the simplified term, external integration to refer to the forward and backward operational integration.

The argument that integration of business processes enables organizational agility, although not systematically explored, is consistent with previous literature. A classic example of electronic integration leading to agility is that of Dell. By integrating with customers and suppliers, Dell maintains inventory turnover at 30 per year with a highly complex and diverse product line, and has grown at the rate of 57% per year (Magretta, 1998). Christopher (2000) explains how a Spanish fashion company has gained agility in sensing and responding to customer needs through its process integration activities that span 300 smaller companies constituting its suppliers. Similarly, numerous organizations such as Ford Motor Company, Boeing Aerospace Corporation, Unisys Corporation and NEXT Inc., have also achieved agility through process integration (Youssef 1992).

A cornerstone argument of this paper, therefore, is that integration with the extended enterprise makes a focal firm better able to sense and respond to market needs. Through EI actors in the extended enterprise work in tandem and share knowledge and increase the scope of their core business competencies. This increase in knowledge integration and business process scope leads to firm sensing and responding agility respectively.

Knowledge Integration

We define knowledge integration as the combination of specialized knowledge of organizational components, where knowledge may comprise of information, technology, know-how or skills (Grant and Baden-Fuller, 1995). We conceptualize knowledge integration as being composed of two components. First, internal knowledge integration, refers to the combination of knowledge within the firm, and spans organizational units such as IT, manufacturing, marketing, and the like. Second,

external knowledge integration, refers to the combination of knowledge sources lying outside of organizational boundaries, such as firm partners, suppliers, customers (Grant, 1996).

Efficiency requires knowledge to be acquired and stored in specialized clusters but realization of its potential advantages requires bringing together many types of knowledge from these specialized clusters (Grant and Baden-Fuller, 1995). Therefore, knowledge clusters that do communicate develop shared understandings and common language and are better equipped to comprehend new information and realize its potential (Grant, 1996). This paper argues that knowledge integration (both internal and external) leads to sensing agility and that knowledge integration is enabled through EI. The following sections elaborate on these arguments in further detail.

Electronic Integration and Internal Knowledge Integration

EI of business activities (primary as well as support) serves as an important enabler of internal knowledge integration. EI allows for the creation of standardized communication protocols and data schemas (Barki and Pinsonneault, 2005) which may have the effect of reducing the mental differences of knowledge clusters (Galunic and Rodan, 1998). Thus, a common language and shared meanings can emerge and departmental units that operated in isolation in the past can start interacting and integrating knowledge (Grant, 1996; Mitchell, 2006).

Integration of operational activities streamlines the primary operations and improves the task efficiencies and coordination among the units (Gattiker and Goodhue, 2005). This improved coordination makes them more responsive to each other and brings together different organizational units' perspectives. Through an ethnographic study, Carlile (2002) showed how a CAD system, serving as a repository for supplying a common reference point of data, measures and labels, allowed for development of shared definitions of the issue that helped in cross-boundary problem solving. Using the standardized forms and reporting formats of the system the engineers in different domains were able to understand the other party's perspective and integrate knowledge from disparate domains which was not possible before the system. Due to the development of these shared understandings, organizational units engage in more exchange relations and increase knowledge flows within organization (Tsai, 2002). This brings novel insights and knowledge integration among units (Galunic and Rodan, 1998).

In addition to the operational units, there is also a need to integrate knowledge of the functional units. Functional units support the primary activities of the firm and play a key role in managing firm resources. EI with functional units standardizes work processes and data (Volkoff, Strong and Elmes, 2005) and improves coordination and knowledge integration. Consider the case of a firm that needs to increase its production or change the work processes by incorporating a newer skill that only few of its employees possess. If such a firm does not keep its support functions (e.g. human resources) aligned and closely coordinated, the entire business process may fall apart. However, if the support functions are integrated with the primary activities of the firm organizational units will seamlessly coordinate and gain on each others knowledge and hence transition would be smooth. ERP systems are a case in point.

Moreover, EI of internal functional activities facilitates knowledge integration by reducing conflicts between operational and functional units. For instance, enterprise systems that attempt to integrate data and processes of firms (Brown and Vessey, 2003) integrate information from operational as well as functional units in order to reduce conflicts arising due to goal differences of various operational (e.g. manufacturing) and functional units (e.g. sales, human resources) (Volkoff et al., 2005). The conflicts arising from these differences are a barrier to knowledge integration and can be allayed through coordination mechanisms such as communication, mutual understanding and standardization of work. Hence, it is hypothesized that,

H1a: Internal- operational EI has a positive effect on the integration of specialized knowledge of organizational units (internal knowledge integration).

H1b: Internal- functional EI has a positive effect on the integration of specialized knowledge of organizational units (internal knowledge integration).

Electronic Integration and External Knowledge Integration

Integration of external knowledge is dependent upon the integration of operational activities that span two areas: external-operational-forward (EOF) and external-operational-backward (EOB). We refer to these two types of integration simply as external integration. External integration allows integration of processes reaching customers of the firm as well as its vendors, suppliers and partners (Barki and Pinsonneault, 2005). Such integration allows being in touch with the customer and thus being able to gain knowledge from the customer directly through the use of CRM systems, web portals for customers, etc. It also allows the development of routines that are the basis of coordination, information sharing as well expertise location with the suppliers and vendors of the firm (Dyer and Singh, 1998).

The process of external EI requires that the actors involved in the process thoroughly understand each others end-to-end processes, become aware of their interdependencies and create inter-unit linkages (Malhotra, Gosain and El-Sawy, 2007). Such linkages are the primary means of knowledge integration among varying units (Tasi, 2001).

EI also imposes design rules that force partners involved in the business process to map interfaces seamlessly with each other and in the process evolve together by knowledge integration (Brusoni and Prencipe, 2006). For instance, Toyota uses its supplier hub to keep in touch with its suppliers and continuously improve its own and their processes to reduce costs and remain competitive by leveraging each other's knowledge (Dyer and Hatch, 2004).

Literature suggests that firms are able to span not only the syntactic boundary but also the semantic boundaries of the firm through external integration (Malhotra et al., 2007). For instance, through external integration a firm can provide its suppliers initial product design information and get their feedback for improvements and adjustments. Such high level exchange and collaboration enabled through external integration allows access to knowledge pools outside of the firm boundaries and entails integration of knowledge embedded in the network of the firm. Hence, it is proposed,

H2: External Integration has a significant positive effect on external knowledge integration.

Knowledge Integration and Sensing Agility

Opportunities can exist in varying forms ranging from new ideas to improvements in products and services to the creation of new products that capture customer attention and create value for them. Sensing opportunities and threats in an organization's environment requires that problems and opportunities be viewed from differing perspectives. Hence there is a greater probability that a firm which is able to integrate knowledge embedded within its different operational and functional units will be able to make sense of its environmental changes and will have a greater sensing agility (e.g. Leonard and Sensiper, 1998).

Innovative new ideas require the integration of different and highly specialized knowledge (Aranda and Molina-Fernandez, 2002). Hence, firms that bring together knowledge from diverse internal units are able to sense and assess opportunities and threats better than firms that do not integrate knowledge within the organization (Nonaka, 1994; Okhuysen and Eisenhardt, 2002).

In addition to internal KI, sensing agility is also improved by external knowledge integration through increased intellectual depth afforded by creative abrasion (Leonard and Sensiper, 1998). Creative abrasion is the process through which cycles of divergent thinking culminate to convergent thinking and innovation. For instance, Toyota has emerged as a market leader, not by keeping its suppliers at arms length, but by continuous integration of information and knowledge and this has nurtured a cycle of continuous innovation which keeps Toyota always ahead of the competition (Dyer and Hatch, 2004).

Integration of knowledge from internal and external sources allows access to intellectual capital, and promotes opportunity scanning and competence enhancements which translates in an increased capability to sense environmental threats and opportunities (Powell, Koput, Smith-Doerr and Owen-Smith, 1999). Moreover, a firm which integrates knowledge with its internal units, partners and customers also expands the range of the environment which it surveys hence it becomes an extended enterprise (Rai et al., 2006) which is better equipped at sensing its environmental changes. Hence, it is proposed,

H3a: Internal knowledge integration leads to an increased ability to sense market opportunities and threats.

H3b: External knowledge integration leads to an increased ability to sense market opportunities and threats.

Knowledge Integration and Responding Agility

In addition to enabling sensing agility, knowledge integration also enables responding agility of a firm. Production of value creating products and services which serve as a response to market threats or opportunities typically requires the application of specialized knowledge of various organizational units (Grant and Baden-Fuller, 1995). The integration of knowledge (internal and external) is essential for responding agility since many products and services draw upon knowledge of partners in a network and are not produced by self-contained firms. For instance, even a relatively low-tech subassembly such as a car seat requires that the seat manufacturer has access to the design knowledge of the auto manufacturer and the auto manufacturer has access to the technical and manufacturing knowledge of the seat manufacturer (Grant and Baden-Fuller, 1995).

Knowledge integration (internal and external) promotes responsiveness between partnering firms and can create the effect of two distinct units behaving as a unified whole (Barki and Pinsonneault, 2005). Thus, interdependent organizational components are able to respond, adjust and adapt quickly to the needs of other components. Since both, the internal knowledge integration and external knowledge integration might be required for creating a highly responsive whole consisting of distinct parts, it is argued that,

H4a: Internal knowledge integration leads to an increased ability to respond to market opportunities and threats.

H4b: External knowledge integration leads to an increased ability to respond to market opportunities and threats.

Electronic Integration and Core Process Competencies

Core Process Competencies

The core competence of a firm is a bundle of skills and technologies that enable the firm to provide a particular benefit to customers (Hamel and Prahalad, 1994). Core competencies of a firm are thus the ability to respond to market needs primarily through keeping in touch with the customer, efficient manufacturing and streamlined distributing as well as innovation.

From the three categories of core competencies (Hamel, 1994), two are particularly relevant for this paper: *Integrity-related* competencies include efficient manufacturing operations, streamlined supply chains and integrated business processes (Ravichandaran and Lertwongsatien, 2005). *Functionality-related* competencies include the capability to offer distinctive products and services through new product development and innovation capabilities of the firm (Ravichandaran and Lertwongsatien, 2005).

EI, enabled by technologies such as SCM systems, ERP systems, EDI, VMI etc., plays a central role in increasing the scope of core business process competencies (e.g. Magretta, 1998; Rai et al., 2006). EI creates an infrastructure allowing businesses to reconfigure and rebundle firm processes with speed. This integrated infrastructure allows for fast reconfiguring of processes due to system modularity and standardization (Malone et al., 1999). This also implies that through EI firms have the opportunities to connect with a wide range of partners quickly to gain access to competencies that the firms themselves lack. In sum, the scope of firm process competencies increases through EI due to an increase in firm ability to quickly reconfigure its business processes or connect to a wide range of partners, which translates into an increase in firm responding agility.

Internal-Operational EI and Core Competencies

Internal-operational EI affects both integrity-related and functionality-related competencies of the firm. Internal-operational EI allows for diverse organizational units involved in the manufacturing, materials management and similar processes to be coordinated with each other and be responsive to changing requirements (Barki and Pinsonneault, 2005). This responsiveness

among business units affords the manufacturing process within the firm to be highly adaptive to changes in demand, process design, process technology and material supply (Swafford, Ghosh and Murthy, 2006) and thus improves the integrity-related competency.

Similarly, internal operational EI also helps the functionality-related competency by allowing for disparate units to work together through communication and coordination that enables innovation and new product development. One reason for EI of internal operational activities to lead to improved functionality-related competency is its ability to allow redefinition of the business scope. When organizational units collaborate in the manufacturing process they share expertise which improves the final product and sometimes results in radically new products (Bierly and Chakrabarti, 1996). Hence, it is argued that,

H5: Internal-operational EI has a significant positive effect on core business competencies (integrity-related and functionality-related)

External Integration and Core Competencies

Since integrity-related competencies are related to the firm's efficient manufacturing operations, streamlined supply chain and integrated business processes, external integration helps by streamlining operations across the supply chain and manufacturing processes. This enables smooth flows of information, goods, and finances (Rai et al., 2006) across organizational boundaries. After EI, the chain of formerly discrete activities underlying a firm's business processes become a system of value-adding processes (Shah, Goldstein and Ward, 2002).

External integration, due to its inherent nature of promoting responsiveness within the extended enterprise, also affords a company the ability to reengineer its business processes at a much faster rate if the need arises (Swafford et al., 2006). Hence firms have a wide range of process options (as afforded by partners and suppliers) and the ability to exploit them to produce quality products in response to changes in raw-material supply, changing product/service characteristics as well as technological process enhancements.

Finally, external integration has a positive effect on integrity-related competencies because such integration increases the speed and range of logistic activities (Paulraj and Chen, 2007). EI has the potential to improve collaborative planning in the logistics of the firm and thus eliminates bottlenecks and facilitates demand-driven operations. Thus, it is proposed that,

H6a: External integration has a significant positive effect on integrity-related core business competencies

External integration also enables functionality-related competencies. As mentioned above, functionality-related competencies are related to the ability to offer distinctive new products and services through new product development and innovation capabilities of the firm. Shah and colleagues (2002) found that firms that have complete systems integration with supply chain partners engage in collaborative new product development across firms using systems such as EDI and web-based interchange (WBI). Such collaborative systems allow each supply chain partner the ability to manipulate and make changes to shared designs. Moreover, EI increases the speed at which products and services can be developed and delivered to customers (e.g. Magretta, 1998).

Finally, external integration increases the scope of functionality-related competencies by increasing the range of actors with which a firm can collaborate. For instance, EI allows the firm the flexibility to connect to a greater number of partners in its value-chain and it allows the flexibility to switch partners at a much faster pace if the need arises. The ability to connect to partners who have competencies that the focal firm lacks increases the scope of competencies (Wang, Lo and Yang, 2004). This is related to yet another impact of EI on functionality-related competencies that related to the ability to identify and enter new market segments. EI allows for creation of network ties with new partners which might already be serving in an unexploited market. Once alliances have been created with such actors, firms can offer complementary products which cater to customers' unmet needs. It is therefore proposed that,

H6b: External integration has a significant positive effect on functionality-related core business competencies.

Core Business Process Competencies and Responding Agility

A key characteristic of core competencies is that they are not functionality specific and can be applied across functionalities (Hamel, 1994). This allows firms to be agile in responding to customer demands and match opportunities with speed by quickly transferring their expertise to new markets and products. For instance, Sony's expertise in creating miniaturized products allowed it to capture Dell's demand for LCDs (Magretta, 1998). Core business competencies of a firm thus provide a base for the firm to respond to market opportunities (Sanchez, Heene and Thomas, 1997).

Core business process competencies of a firm thus play a crucial role in a firm's ability to *respond* to market opportunities. Hence in order to be able to quickly respond to changes, firms need these capabilities to be responsive. For instance, reconfigurable and responsive supply-chain processes allow flexibility in the supply-chain that reduces inefficiencies, excessive inventory investments, missed production schedules, poor customer service, etc. (Christopher, 2000). Thus, the elimination of such problems transpires into agility in responding. Similarly, new product development capability allows firms to integrate and reconfigure resources to combine the varied competencies of discrete units to create new products and services (e.g. Dougherty, 1992). It is therefore argued that,

H7: Core business process competencies lead to an increased ability to respond to market opportunities and threats.

CONCLUSION AND CONTRIBUTIONS

Although studies have explored agility and its importance (Overby et al. 2006; Sambamurthy et al. 2003), the literature does not sufficiently explain the role of IT in achieving agility. We still do not know what aspects of IT create digital options which are required for firms to be able to sense and respond to opportunities in the environment. This paper contributes to the agility literature by addressing this gap and providing a complementary understanding. This paper proposes that the concept of organizational integration is particularly relevant for creating digital options. It allows us to understand how synergies formed through internal and external integration can transform into firm agility through the processes of knowledge integration and core process competence scope expansion. This paper has thus attempted to contribute to the literature by presenting a theoretical model of the role of IT in achieving firm agility.

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