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IT Based Knowledge Capability and Commercialization of Innovations: Modeling the impacts on ambidexterity and absorptive capacity

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In seeking answer to the question what role can IT based knowledge Capability play in commercialization of innovation, we looked at potential and realized absorptive capacity and ambidexterity . We posit that a firm's absorptive capacity and ambidexterity (ability to explore and exploit) affect its ability to commercialize innovations. Further, absorptive capacity too can be an antecedent to ambidexterity. IT based knowledge capability (which is an instantiation of IT capability) is found to positively moderate the relationship between ambidexterity and commercialization of innovations, and also is an antecedent to potential and realized absorptive capacity. We tie the seemingly isolated bits of literature together into an integrative theoretical and tested it. We assumed the presence of necessary networks and resources that lead to absorptive capacity and ambidexterity.

Keywords: Knowledge Capabilities, IT Capability, Absorptive Capacity, Ambidexterity, Potential Absorptive Capacity, Realized Absorptive Capacity, Ambidexterity, Exploration, Exploitation, Commercialization of Innovations

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Abstract

In seeking answer to the question what role can IT based knowledge Capability play in commercialization of innovation, we looked at potential and realized absorptive capacity and ambidexterity . We posit that a firm's absorptive capacity and ambidexterity (ability to explore and exploit) affect its ability to commercialize innovations. Further, absorptive capacity too can be an antecedent to ambidexterity. IT based knowledge capability (which is an instantiation of IT capability) is found to positively moderate the relationship between ambidexterity and commercialization of innovations, and also is an antecedent to potential and realized absorptive capacity. We tie the seemingly isolated bits of literature together into an integrative theoretical and tested it. We assumed the presence of necessary networks and resources that lead to absorptive capacity and ambidexterity.

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Introduction

To introduce innovative new products and services to the market is perhaps one of the most important capabilities that a firm can possess in order to be successful. For example, Nokia and Sony-Ericsson, each introduced over fifty models of cellular phones in 2008, penetrating every possible market niche with their portfolio. The increased pace in innovating and commercializing not only helps the innovators to be successful but also raises the bar for competitors. For instance, in its response to Apple's I-Phone and alliance with AT&T, Samsung launched its "Instinct" with an alliance with Sprint. Further, realizing the opportunity in captive devices and mobile searches, Google too launched its own phone. Whether or not the competitive response will be successful remains to be seen. If not they will form the list of failed commercialization that includes everything from vitamin enriched sodas, and smokeless cigarettes, to online bidding for groceries and gas, to failed automobile models. While

companies clearly try hard to launch new products into the market, not all of them are successful. Why is it then, that some firms are much better commercializing innovations than others? This work makes an attempt to answer this question.

It has been argued that successful commercialization of innovation is necessary in order for firms to be competitive (Nevens, Summe & Uttall, 1999). Further, scholars have posited that successful commercialization of innovations is of strategic importance to firms (Nerkar & Shane, 2007), and is necessary to advance the economy at large (Cohen & Levinthal, 1990; Eisenhardt & Martin, 2000; Zahra & Neilson, 2002; Sorensen & Stuart, 2000). The ability to commercialize can improve a firm's market penetration and dominance (and even help that firm to create a new market), which contributes to the attainment of sustained leadership and firm longevity, which in turn, positively impacts the health of the economy within which the firm operates (Wallsten, 2000; Lerner 1999; Salamenkaita, & Salo, 2002). It therefore is no surprise that governments at nearly all levels attempt to mitigate market and systemic failures to eliminate structural economic and/or industry-level rigidities and promote commercialization of innovations. A better understanding of the successful commercialization of innovations is thus an important determinant for the health of the economy at multiple levels.

There exists an emerging body of research that helps us understand which organizational characteristics correlate with a firm's ability to commercialize innovation. It has been suggested that the ability to commercialize innovations correlates with a firm's capabilities (Damanpour 1991; Dourgerty & Hardy, 1996; McGrath ,et al. 1996; Pennings & Harianto, 1992, Teece, Pisano & Shuen, 1997), human resource practices (Nerker, McGrath & Macmillan, 1996; Scott & Bruce, 1994), incentive structures (Nevens, Summe & Uttal, 1999; Teece, 1986), the nature of top management teams (Bantel & Jackson, 1989; Howell & Higgins, 1990), and the external environment within which the firm operates (Abrahmson & RosenKopf, 1993; Keats and Hitt, 1988; Milliken, 1987; Wade, 1996). Much of the cited literature, however, treated innovation and its commercialization as the same construct. In fact, commercialization in many cases was

assumed. While this growing body of work undoubtedly contributes to our understanding of successful commercialization, a model of the factors affecting commercialization of innovation is the next step in order to answer the question as to why some firms are better at commercialization of innovation than are others.

Firms typically depend on products developed three to five years ago for large portions of their current sales. Correspondingly, they find themselves aiming three to five years in advance at an elusive future target that is competitive in the future (Burgelman, Christensen & Wheelwright, 2006; Grove, 1996). Additionally, globalization of markets has put more pressure on firms to commercialize innovations in order to fend off global competition and/or to expand into global markets (Hamel & Prahalad, 2002; Hamel & Getz, 2004; Collin & Porras, 1999; De Geus 1997; Hall, 1997; Hygens, Baden-Fuller, Van Den Bosh, Volberda, 2001; Huber, & Glick, 1993; March 1991, March 1995; Meyer & Zucker, 1987). Thus, the need to bring innovations to market successfully is greater than ever. For example, Nokia responded to this global stimulus with the introduction of over eighty models of cellular phones and Sony responded with fifty models of portable audio players, with no apparent end to innovative products from either firm. The same is true for rapidly growing companies like Samsung, LG, and Sony. Rapid technological development simultaneously enhances and exacerbates the need for successful commercialization of innovation. Advances in information technology, greater ease of use of these technologies, led to shorter cycle times in developing new technology applications. These resulted in greater process improvements and more efficient generation of new products and product changes (Brynjolffson & Mendelson, 1993; Gulati, Sawhney, & Paoni, 2002), which further increased the speed with which firms and their competitors need to innovate and commercialize.

While we agree that innovation characteristics are a necessary component of future market success, innovation *per se* is not sufficient to ensure that success. Instead, innovations generally lead to market success through the process of commercialization (Drucker, 1985).

We, therefore, focus our model on commercialization of innovation and the factors that enable and/or influence that capability.

In this study, we examine the knowledge capabilities that are supported and/or enabled by information technology (IT) and posit a theoretical model that establishes a link between IT and commercialization derived through IT-based knowledge capabilities. This study is motivated by two major reasons. ***First***, IT has become critical for supporting knowledge management initiatives and nurturing innovation (Alavi and Leidner 2001). IT enables to better manage the creation, dissemination, and usage of knowledge and makes firms more productive and competitive (Davenport, Prusak, and Strong 2008). IT-based knowledge capabilities are thus consequential to firm strategy (Steward 2003) and value creation (Piccoli and Ives 2006). However, an extensive survey of the existing literature on IT and management reveals that there is a conspicuous gap in the literature between IT and innovation. IT's contribution and assistance in supporting, building, and strengthening a firm's knowledge capabilities has been increasingly recognized (e.g. Alavi and Leidner 2001; Sambamurthy and Subramani 2005; Tanriverdi, 2005). The link between knowledge capabilities and firm innovation has also been emphasized (e.g., Cohen and Levinthal 1990; Leonard-Barton 1998). Yet, limited research has been done to systematically examine the link between IT-based knowledge capabilities and innovation. A few conceptual and anecdotal studies have examined the relationships between IT-based knowledge capabilities and innovation (e.g., Davenport, 1993; Holsapple and Singh 2003; Davenport, Prusak, and Strong 2008). Even fewer studies have empirically investigated the aforementioned (e.g., Tippins and Sohi 2003; Sabherwal and Sabherwal 2005. As more companies turn to IT in an attempt to enhance firm competitiveness, this gap must be systematically addressed by empirically examining specific innovation outcomes and processes from idea generation to new product introduction that may benefit from IT investment and practice. By doing so, an in-depth understanding of the relationship between IT-based knowledge capabilities and firm innovation becomes critical. ***Second***, mixed results have been

found in the literature in establishing a positive relationship between IT investment and its effect on firm performance, which may be attributable to a number of factors such as sample size, data sources, and industry characteristics (Kohli and Devaraj 2003). However, emerging empirical evidence has shown that IT does not necessarily create a competitive advantage and there is no significant direct relationship between IT investment and firm performance (e.g., Mahmood and Soon, 1991; Zahra and Covin, 1993; Hitt and Brynjolfsson, 1996; Powell and Dent-Micallef, 1997; Tippins and Sohi 2003; Kohli and Devraj 2003). Here, we postulate that firm innovation may be an important intermediate factor between IT investment and firm performance outcomes and an investment in IT itself is less likely to drive competitive advantage for firms. Instead, to extract strategic value from IT, firms have to use IT to exploit IT-based *knowledge capabilities* to continuously *innovate* their products, services, and business processes. To our knowledge this relationships has not be systematically examined in the IT literature.

To bridge the gap in the existing literature, we draw on knowledge-based view of the firm to examine the link between IT and commercialization of innovations. We argue that IT-based knowledge capabilities better enable firm innovation by enabling new idea generation and facilitating the conversion of these ideas into new products and services that can be introduced into the market. We collect secondary data about the IT-based knowledge management practice and innovation processes of 110 firms and use path modeling equation modeling to test our hypotheses.

The rest of this paper is organized as follows. In the next section we discuss our theoretical model alongside the testable hypothesis and theoretical underpinnings. It begins with the dependent variable of this study - ability to commercialize innovations. Then, we concentrate on a discussion of antecedents and mediators to commercialization, including ambidexterity, and absorptive capacity. We also discuss the how IT based knowledge capability moderate the influence of ambidexterity and absorptive capacity on commercialization of innovations. We then

describe our data collection and analysis. We conclude the paper by interpreting our results and discussing the implications and contributions of our study.

Theoretical Model and Hypothesis Development

Our theoretical model is shown below (Figure 2) to provide an easier assimilation of the discussion. We also include below a table of definitions of our constructs (Table 1).

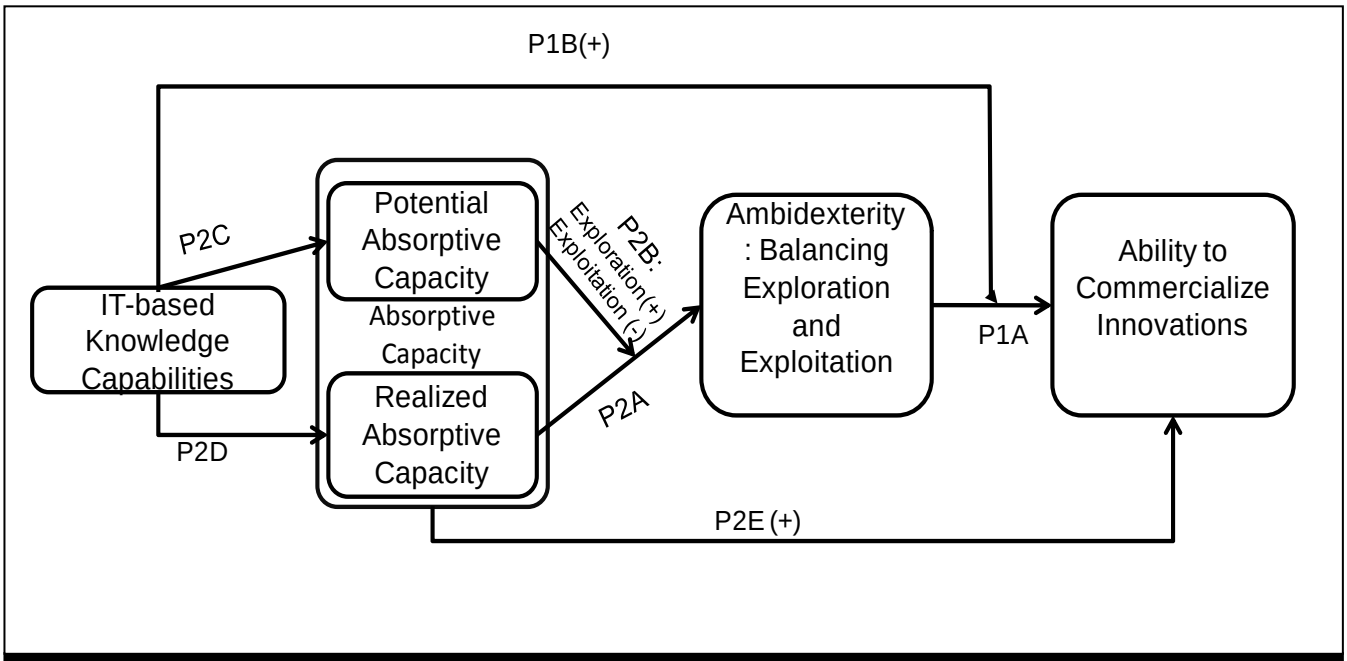

Figure 1. Theoretical model for hypothesis development

Table 1: Construct Definitions

Construct name	Definition
Ability to Commercialize Innovations	A firm's capacity to bring a product or service into a market and reach the mainstream of the market beyond the initial adopters. A minimum threshold for "success" in commercialization is thus embedded in our definition. There are three aspects to our definition (a) recognize a market for an innovation, (b) develop the products and (c) Sell/ distribute the product. While the last two can be outsourced, the first one cannot.
Ambidexterity	The property of an organization to balance activities of exploration and exploitation.
Absorptive Capacity	The limit to the rate at which a firm can absorb scientific or technological information and/or a limit to the quantity of such information that can be absorbed. *Potential Absorptive Capacity*: knowledge acquisition and assimilation, captures efforts expended in identifying and acquiring new external knowledge and in assimilating knowledge obtained from external sources. *Realized Absorptive Capacity*: knowledge transformation and exploitation, encompasses deriving new insights and consequences from the combination of existing and newly acquired knowledge, and incorporating transformed knowledge into operations
IT based knowledge Capability	IT capability is the ability of information technology to create resources that can help generate firm performance, and sustainable competitive advantage. By IT based knowledge capabilities we focus on those technologies that enable, knowledge acquisition, knowledge internalization, knowledge sharing, knowledge generation and knowledge application

Ability to Commercialize Innovations

According to Burgelman, Christensen, & Wheelwright (2006), the innovation process is defined as the combined activities leading to new, marketable products and services and /or new product delivery systems. Many scholars have combined innovation and commercialization within the same construct and Burgelman and colleagues (2006) similarly, include the process of getting innovation to market within their definition of innovation. However, others have kept innovation and commercialization as separate and distinct constructs.

Commercialization of innovation has been defined as the act or activities required for introducing an innovation to market (Kelm. et al., 1995; Narayanan., et al. 2000; Nambison & Sawhney, 2007; Andrew & Sirkin, 2003; Kwak, 2002; Nerkar & Shane, 2007). Nerkar & Shane (2007) measured commercialization of innovation as the early indication of commercialization,

operationalized as the first sale of the target product or service. Moore (1991; 2000), on the other hand, posited that when an innovation is introduced in the market, only technology enthusiasts procure, and such enthusiasts comprise less than three percent of the market. Moore (2000) argued that the larger mainstream market is comprised of pragmatists and conservatives, and so a successful commercialization is one that captures this mainstream market in which case the innovation is diffused across technology enthusiasts as well as pragmatists and conservatives. Reaching the mainstream market in this manner is difficult, and so we believe that the threshold for 'successful' commercialization of an innovation will likely lie somewhere between these two extremes – single sale on the one hand and saturating the mainstream of a market on the other. Converting technical innovations to products and services entails the development of manufacturing and marketing capabilities, and assets such as manufacturing facilities and service and distribution networks (Ahuja, 2000; Mitchell, 1989; Teece, 1986).

We therefore define the ability to commercialize innovations as a firm's capacity to bring a product into a market and reach the mainstream of the market beyond the initial adopters. A minimum threshold for 'success' in commercialization is thus embedded in our definition. There are three aspects to our definition – (a) recognize a market for an innovation, (b) develop and manufacture it into a product and (c) sell/distribute the product through distribution channels. Of these, while the last two can be outsourced, the first one is of fundamental importance. Thus, the ability to commercialize innovations primarily lies in an organization's ability to recognize current and emerging markets for current technological innovations and secondarily it depends on the firm's ability to manufacture and sell the product either buy itself of by subcontracting.

IT based Knowledge Capability

IT capability is the ability of information technology to create resources that can help generate firm performance, and sustainable competitive advantage. IT based knowledge

capability however, is a subset of IT capability that that enable, knowledge acquisition, knowledge internalization, knowledge sharing, knowledge generation and knowledge application

Tanriverdi (2005) operationalized IT-based knowledge capability as IT relatedness and showed IT relatedness of business units enhances the cross-unit KM capability of the firm. The KM capability creates and exploits cross-unit synergies from the product, customer, and managerial knowledge resources of the firm. Johnston and Vitale (1988) showed how IT helps in managing and strengthening intra and inter interorganizational networks that help creating competitive advantage. Bharadwaj, Sambamurthy and Zmud (1999) showed that IT capability is a second order construct where external IT linkages (similar to External Knowledge Networks) is first order reflective constructs measured through manifests like (a) technology-based links with customers (b) technology-based links with suppliers (c) IT-based entrepreneurial collaborations with external partners and (d) Leveraging of external IT resources (IT vendors and IT service providers). Thus, their paper supports the fact that IT-capability can improve the relationships that a firm posses with its customers, suppliers. While, such relationships do affect a firm's ability to commercialize innovations, IT capability can strengthen the relationship.

Mata et al. (1996) applied the resource based theory of firm to examine if IT is a source of sustained competitive advantage (measured through firm performance). They found that the only resource that explained the variance in firm performance was Managerial IT skills. The work of Powell and Dent-Micallef (1997) shows that firms use IT to create and manage supplier networks, which results in creation of competitive advantage.

Brynjolfsson and Hitt (1996) argue that the impact of IT on firms performance are usually implicit (e.g., improved product design, better customer satisfaction, increased market responsiveness) and are achieved by building synergistic relationships across organizational units and with suppliers and customers. While, IT can bring into existence of such relationships, it also moderates the existing ones. Bharadwaj (2000) building on the works of Brynjolfsson and Hitt, conceptualized a relationship between IT capability and firm resources. More specifically,

she argued that IT intangibles, such as IT enabled customer relationship management, development of knowledge assets, and synergies created by IT enabled collaboration among organizational units, are the source of firm performance. Kwon and Watts (2006), in evaluating the performance based impacts of two types of IT value practices: traditional efficiency based and knowledge and knowledge based had two items (KM1: “has increased learning synergies across different groups and divisions in your company” and KM3: “ has enhanced your company’s ability to coordinate the different skills and expertise of your employees” p.351) in their questionnaire actually measures how IT capability has enhanced internal knowledge networks. The treatment however remained implicit.

Wade and Hulland (2004) extended Mata et al.’s (1995) and Barney’s (1991) work, by mapping the parameters of resources that make them vehicle of sustainable competitive advantage, with three types of IT resources: Inside out, Outside in and Spanning. They showed that for advantage creation the value of information, rarity and appropriability are important but for sustenance, imitability, substitutability and mobility are more important. Bhatt and Grover (2005) also argued that firms are entities within the greater ecosystem, where the capabilities of IT resources span across firm boundaries and thus IT values can be best harnessed by means of inter-organizational alliances and collaborations among the entities that exist within a business ecosystem. Thus, not only IT can help manage existing networks and resources but also create new ones.

Ray et al.’s (2005) analysis of the role of IT on the performance of customer service processes revealed that the superior relative performance from IT rests less on the level of IT spending or technical skills and more on creating effective partnerships and alliance between IT and business managers. In fact, the study showed that technical IT skills, generic technologies and IT spending did not explain significant variance in customer service performance, however, knowledge processes enabled by IT (such as knowledge sharing and flexibility) have a direct impact on process performance.

IT capability encompass IT infrastructure, human IT skills, and IT-enabled intangibles (Bharadwaj 2000). IT infrastructure provides the necessary hardware and software that allow for creating networks that enables firm innovation. The unique characteristics of IT infrastructure have enabled firms to implement the right applications at the right time and meanwhile broadened avenues for technological innovation (Sambamurthy et al. 2003). IT infrastructure enables firms to (1) identify and develop key application rapidly, (2) share information across products, services, and locations, (3) implement common transaction processing and supply chain management across business processes, and (4) exploit opportunities for synergy across business units represent the type of causally ambiguous resources (Reed and DeFillipi 1990). Moreover, firms with strong human IT skills are not only better equipped to anticipate and address future business needs of the firm, but also are better able to innovate valuable new product features before competitors and achieve intangible benefits such as customer satisfaction (Bharadwaj, 2000)**.**

The IT capabilities enables effective execution of intra-organizational networked business processes because IT has put information on everyone's figure tips equipping lower level management teams to handle decisions more effectively (Ellis 2003). Brynjolfsson & Hitt (1996), and Brynjolfsson and Mendelson (1993) correlated the benefits reaped from IT investment with the inherent organizational structure. They have argued that centralized control and bureaucracy impedes diffusion of innovation, knowledge, and creative thinking which are critical for IT's ability to create value. Gold, Malhotra, and Segars (2001) in measuring the impact of technology infrastructure organizational effectiveness used two items, which can be used to measure IT enables internal and external knowledge network. The items were (a) employee to collaborate with members within organization and (b) and employee to collaborate with members outside the organization.

Applying the aforementioned findings from the literature, we argue that IT capability helps support the creation and maintenance of knowledge networks that are developed through

strategic alliances and collaborations among the entities within and between firms. Therefore, from the aforementioned discussion we surmise, while several firms may possess the same information technology capabilities, only the ones that possess the ability to create a network of knowledge processes within and outside of its organizational boundaries will be successful at expanding and exploiting the values of IT capabilities to create innovation (Barney 1991).

Ambidexterity

In order for an organization to succeed over the long term, it needs to master both adaptability and alignment, a dual mode that is termed as *ambidexterity* (Brikinshaw and Gibson, 2004; Gibson and Brikinshaw, 2004; Raisch and Brikinshaw, 2008). As an example, Brikinshaw and Gibson (2004) noted that while Nokia launched a vast array of new mobile tech

nology product offerings, they also continued to make pricing and other product decisions in order to continue to be the dominant handset provider. Focusing too much on alignment makes an organization lose long-term vision, while a greater emphasizing adaptability over alignment means building tomorrow's business at the cost of today's (Brikinshaw and Gibson, 2004). Similarly, Duncan (1976) reasoned that in order to innovate successfully, organizations must balance two stages of innovation namely, initiation and implementation, and he referred to this balance as ambidexterity. Specifically, during the initiation phase, an organization needs low formalization, and low centralization, whereas during implementation the organization tends high formalization with low complexity and high centralization.

Similar to Brikinshaw and Gibson's (2004) idea of alignment and adaptability, and Duncan's (1976) idea of blending initiation with implementation, is March's (1991: p.71) concept of exploration and exploitation:

> "Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution. Adaptive systems that engage in exploration to the exclusion of exploitation are likely to find that they suffer the costs of experimentation without gaining many of its benefits. They exhibit too many

> undeveloped new ideas and too little distinctive competence. Conversely, systems that engage in exploitation to the exclusion of exploration are likely to find themselves trapped in suboptimal stable equilibrium. As a result, maintaining an appropriate balance between exploration and exploitation is a primary factor in system survival and prosperity." (p.71)

Seen from the sense of Brikinshaw and Gibson (2004), March's exploration would be Nokia's experiment with newer technology and exploitation would be their continuing investment and commitment in their existing product lines.

Exploration encompasses knowledge creation and analysis of emerging and future opportunities, while exploitation is defined as making use of existing knowledge to leverage current opportunities (March, 1991; Wielemaker, 2003; Sidhu, Commandeur, & Volberda. 2008; Zack, 1999; Zack, 2003). Past research has positively linked a balance between exploration and exploitation with organizational self-renewal through constant innovations in volatile business environment (Lewin & Volberda, 1999; Levinthal & March, 1993; Levinthal, 1997; March, 1991; Nahapiet & Ghosal, 1998; Volberda 1998; Volberda & Lewin, 2003; Handy, 1990; Huber & Glick, 1993; Hamel & Getz, 2004; March, 1991, 1995; Volberda; 1998; Volberda & Lewin, 2003). In addition, a number of studies collectively have posited that a balance between exploration and exploitation leads not only to organizational renewal but that this, in turn, helps firms to be more innovative and, as a result, such firms are more long-lived (Lewin & Volberda, 1999; Levinthal & March, 1993; Levinthal, 1997; Levinthal & March, 1991; Volberda 1998; Volberda & Lewin, 2003; Dess & Beard, 1984; Hamel & Prahalad, 2002; Hamel & Getz, 2004). While some scholars defined the dual mode of operation of blending adaptability and alignment, exploration and exploitation, efficiency and flexibility as ambidexterity (Brikinshaw and Gibson, 2004; Gibson and Brikinshaw, 2004; Raisch and Brikinshaw, 2008) others (Simsek, 2009) have mentioned that such such a dual model leads to ambidexterity. Combining the work of March (1991), Brikinshaw and Gibson (2004), Gibson and Brikinshaw (2004), and Raisch and

Brikinshaw (2008), we define and restrict our definition of ambidexterity as the property of an organization to balance the two activities of exploration and exploitation.

From a thorough review of literature on ambidexterity Simsek, Heavey, Veiga and Souder (2009) and Simsek (2009) concluded that there are four ways in achieving balance between exploration and exploitation, namely, harmonic, cyclical, partitional and reciprocal. Harmonic balance is achieved through concurrently pursuing exploitation and exploration harmoniously within a single organizational unit (Simsek, et al. 2009). Such a balance competes for scarce resources, leading to conflicts, contradictions, and inconsistencies. Organizational practice and routines are viable antecedents of harmonic balance.

Cyclical ambidexterity is a type of balance in which organizations engage in long periods of exploitation (or relative stability), interspersed by sporadic episodes of exploration (or change). Simsek, et al. (2009), related it to Gersick's (1991) punctuated equilibrium. Antecedents to cyclical amnidexterity are found in human resource practices that emphasize innovation, teamwork, and flexibility (Simsek, et al. 2009).

Simsek, et al. (2009) traced back partitional ambidexterity to Duncan's (1976) work, where he emphasized the role of dual structure of initiation and implementation. Organizational theorist like Tushman and O'Reilly (1996), and O'Reilly and Tushman (2004) envision partitional ambidexterity as an interdependent, simultaneous phenomenon, involving the compartmentalizing and synchronizing of exploitation and exploration within different structural units or divisions of an organization. From a structural perspective, partitional ambidexterity is achieved by creating separate units or divisions for exploitation and exploration (Duncan; 1976; Tushman and O'Reilly, 1996), with each unit embodying distinct strategic and operating logics, cultures, and incentive systems. As explained by O'Reilly & Tushman (2004), the ability to simultaneously pursue both exploitation and exploration results from "hosting multiple contradictory structures, processes, and cultures within the same firm" (2007: 24). While tightly coupled and integrated at the business unit level, these logics must remain loosely coupled

across business units (Benner and Tushman, 2003). In addition, Simsek, et al. (2009) has suggested antecedents to partitional ambidexterity that extend across organizations by using interorganizational networks. In a study of almost 20,000 alliances over a period of ten years, Lavie and Rosenkopf (2006) observed that exploitation and exploration can be pursued both within and across three domains of strategic alliances including the value chain function of alliances, the attributes of alliance partners, and the network position of alliance partners.

Reciprocal interdependence in which the outputs of exploitation from unit A become the inputs for exploration by unit B and the outputs of unit B cycle back to become the inputs of unit A (explains, Simsek, et al. 2009). Ongoing information exchange between organizational units or between organizations enables this. Lavie and Rosenkopf (2006) observed that firms "appear to balance their tendencies to explore and exploit with respect to the nature of their alliances or choice of partners over time and across domains" (2006: 814). Their findings highlight the significance of alliances and interorganizational networks as mechanisms for combining exploitation and exploration across time and units. In this vein, knowledge integration among alliance partners may be especially relevant to the pursuit of this form of ambidexterity (Simsek, et al. 2009).

Ambidexterity and Commercialization of Innovations

The ability of ambidextrous firms to come up with radical new products without hampering the existing markets, make them long-lived (Tushman & O'Reilly, 1996, 2002; O'Reilly & Tushman, 2004). The works of Collin and Poras (1999), Hygens,et al.(2001), Porter (1998), and Van Wijk (2003), suggest that long lived-firms have structural and cultural similarities. Factors within firms that affect ambidexterity include decentralization, a tolerant management style, and sensitivity towards the emerging trends in the environment. Similarly, co-evolutionary theory (Van Den Bosch., et al. 1999; Flier.et al., 2003; Volberda & Lewin, 2003) speaks to the interdependence of organizations and their environments. Combining work on corporate longevity and co-evolutionary theory, Volberda & Lewin (2003) proposed three key

principles of self renewal within organizations: (a) self renewing organizations focus on managing requisite variety by regulating internal rates of change equal to or exceed external rate of environmental change triggered by customer orientation, technology innovation, industry competition, and product obsolescence; (b) self-renewing organizations optimize self-reorganization (Nonanka & Takeuchi 1995); and (c) self-renewing organizations synchronize concurrent exploitation and exploration (Lewin & Volberda,1999; Levinthal & March, 1993; Levinthal , 1997; March, 1991). Thus, the balance between exploration and exploitation arises from sensitivity to the environment and maintaining a compatible organizational structure, which in turn produces organizational longevity.

Hill and Birkinshaw (2006) observed that organizations that are capable of simultaneously building new capabilities and using existing capabilities, (i.e., harmonic ambidexterity) enjoyed higher levels of venture strategic performance through the creation of breakthrough innovations by investing in disruptive technologies. Technologically oriented organizations that engage in successive or cyclic rounds of exploitation and exploration are best equipped to pursue product innovations (Tushman and O'Reilly, 1996; Simsek et al, 2009; Simsek, 2009). By engaging in intensive periods of exploration, business units discover new technologies that not only spur the proliferation of new products, but that may even become established as the dominant design in the industry (Henderson and Clark, 1990). Then, by subsequently shifting to exploitation, business units improve the performance of product innovations through process innovation (Simsek et al, 2009). Partitional ambidextrous firms according to O' Reilly & Tushman (2004) were successful in launching breakthrough products and services and in ensuring the continued high performance of existing products.

We have already mentioned that ambidextrous firms are better able to attain organizational longevity. The key to longevity is in being innovative (Tushman & O'Reilly, 1996, 2002; O'Reilly & Tushman, 2004). From the discussion of types it can be concluded that Ambidextrous organizations are naturally innovative and have the ability to renew themselves

by creating breakthrough products for existing markets and capitalizing on emerging markets (Brikinshaw and Gibson, 2004; Gibson and Brikinshaw, 2004; Jansen, et al. 2006, Raisch and Brikinshaw, 2008; Tushman & O'Reilly, 1996, 2002; O'Reilly & Tushman, 2004; Volberda & Lewin, 2003). Specifically, such organizations have been able to compete in mature market segments through incremental innovations (Abernathy & Utterback, 1978; Christensen, 1992a and 1992b) and in emerging market segments through radical innovations (Burgelman, Christensen, & Wheelwright, 2006; Abernathy & Utterback, 1978; Burgelman & Grove, 1996; Burgelman, 2002; Galunic & Eisenhardt, 1996; Christensen, 1992a; Henderson & Clark, 1990). Being ambidextrous leads a firm to diversify its skills to combine current opportunities with future vision. For instance, the ability of Hewlett Packard to balance its mainstream computing and printing market with emerging IT service markets led to leading products in computers, printers and IT services like HP Open View.

Tushman & O'Reilly (1996) argued that large corporations, such as Johnson & Johnson, and Asea Brown Boveri (ABB), have been able to compete in mature market segments through incremental innovation, and in emerging market segments through discontinuous innovation. Like a juggler who needs to handle multiple markers simultaneously (Tushman & O'Reilly, 1996). They reconcile conflicting demands from their task environment and synchronize and balance concurrent exploration of new opportunities and exploitation of existing ones (Duncan, 1976; Gibson & Birkinshaw, 2004; Brikinshaw and Gibson, 2004; O'Reilly & Tushman, 2004; Tushuman & O'Reilly, 1996). In this way, ambidextrous organizations can renew themselves through the creation of breakthrough products, services and processes without destroying or hampering its traditional businesses (Gibson & Birkinshaw, 2004; Volberda & Lewin, 2003; Tushman & O'Reilly, 1996).

In our definition of ability to commercialize innovations, we included an organization's ability to recognize current and emerging markets as a fundamental component. The ability to balance exploration and exploitation leads to an organization's being cognizant of existing and

emerging markets. Thus, we can propose that being ambidextrous leads a firm to be better at commercialization of innovations. This leads us to propose:

Proposition 1a: A firm that can create a balance between exploitation and exploration is better able to commercialize innovation.

Ambidexterity, IT based Knowledge Capability and Commercialization of Innovations

In the IS Literature the term ambidexterity received lukewarm treatment. Tarafdar and Gordon (2007) conceptualized ambidexterity as an attribute to IS competency and as a property to achieve and balance strategic vision and operational excellence. Exploration entails knowledge creation and analysis of emerging and future opportunities (Wielemaker, 2003; Zack, 1999; Zack, 2003), while exploitation is defined as making use of the existing knowledge to leverage current opportunities. Gold et al. (2001), had items such as (a) identify business opportunities (exploration), (b) coming out with new products (exploitation and commercialization), which collectively translate into ambidexterity. Yet they don't specify the term. Further, Kwon and Watts (2006), in evaluating the performance based impacts of two types of IT value practices: traditional efficiency based and knowledge and knowledge based had item (KM5: "has increased cross functional efforts to explore business opportunities", p.351) in their questionnaire that measures the link between internal knowledge network and exploration stage in ambidexterity. Despite the recognition of the construct in both the papers (Gold et al, 2001 and Kwon and Watts, 2006) there is no mention of the term ambidexterity. While linking IT with organizational capability, Gold et al (2005), measured how IT helps in collaborate employees across and between organizations to explore new opportunities and on how IT capability is used to commercialize newer products. For instance the use of Computer aided Design/ manufacturing (CAD/ CAM) technologies, Content Management systems not only help collaborating but also reduce the time to commercialize innovations. Such technologies potentially reduce the cycle time from patent or conceptualization to production. Hence, IT

based knowledge capability affects the relation ambidexterity has with commercialization of innovations.

Proposition1b: IT-based knowledge capability positively moderates the relationship between ambidexterity and commercialization of innovations.

Absorptive Capacity (Potential and Realized)

According to Cohen and Levinthal (1990) and Jansen, et al. (2005) absorptive capacity is the limit to the rate at which a firm can absorb scientific or technological information and/or a limit to the quantity of such information that can be absorbed (Cohen & Levinthal, 1990; Jansen et al., 2005). Conceptually, absorptive capacity is similar to information processing capacity but at the firm level rather than at the individual level. Absorptive capacity underlies a firm's knowledge capabilities by which the firm acquires, assimilates, transforms, and exploits knowledge resources to produce dynamic capabilities such as innovativeness (Zahra and George 2002). It is critical to developing competitive advantage and often leads to significant innovations (Powell et al. 1996). Networks are salient to absorptive capacity and important for increasing a firm's knowledge base in conjunction with its business partners and for creating new knowledge, which can be observed in the form of new patents (which are embodiments of knowledge), new categories of products and services (which come from understanding the competition and market needs), and in extreme cases, creation of new industries (Jansen et al., 2005). Networks also play an important role in building a firm's absorptive capacity by providing skills and processing abilities that can support acquisition, assimilation, transformation, and exploitation of knowledge to create innovation (Alavi and Leidner 2001; Holsapple and Joshi, 2000; Holsapple and Joshi, 2002; Dehning et al. 2003; Jansen et al., 2005; Lane and Lubatkin, 1998).

Zahra & George (2002) extended the theory by specifying four distinct dimensions to absorptive capacity: acquisition, assimilation, transformation and exploitation. The primary antecedents to absorptive capacity according to Cohen & Levinthal (1990) are:

1. Structure of communication between the organization and entities within its external environment (termed *outward* absorptive capacity).

2. Structure of communication within subunits in the organization (termed *inward* absorptive capacity).

3. Structure of communication between subunits in the organization (termed *cross functional* absorptive capacity).

Some classic examples of outward absorptive capacity are the strategic partnership between Intel and Microsoft (Grove, 1996) and the business ecosystem that Walmart created with its suppliers (Moore, 1993; Burgelman, et al., 2006) or the relationship that Nokia has with academic and research institutions. In each case the experiences or knowledge of one firm or entity increases the limit of absorption of the other entity over the network. A classic example of cross functional absorptive capacity is the tight linkages between design and manufacturing sub-units that has enabled Japanese manufacturing firms to move products rapidly from design through production, marketing, sales, and into the market (Cohen and Levinthal, 1990). The concept was explained in more detail by Clark & Fujimoto (1987), who argued that overlapping product development cycles facilitated collaboration and coordination across subunits within a firm.

In studying the organizational antecedents to absorptive capacity Jansen et al. (2005) and Jansen (2005), distinguished between potential and realized absorptive capacity using work of Zahara and George (2002). *Potential absorptive capacity,* which includes knowledge acquisition and assimilation, captures efforts expended in identifying and acquiring new external knowledge and in assimilating knowledge obtained from external sources (Zahra & George, 2002: 189). *Realized absorptive capacity,* which includes knowledge transformation and exploitation, encompasses deriving new insights and consequences from the combination of existing and newly acquired knowledge, and incorporating transformed knowledge into operations (Zahra & George, 2002: 190)

Absorptive Capacity and Ambidexterity

According to Zahra and George (2002) firms focusing on acquisition and assimilation of new external knowledge (i.e., potential absorptive capacity) are able to continually renew their knowledge stock, but they may suffer from the costs of acquisition without gaining benefits from exploitation. Conversely, firms focusing on transformation and exploitation (realized absorptive capacity) may achieve short-term profits through exploitation but fall into a competence trap (Ahuja & Lampert, 2001) and may not be able to respond to environmental changes. Zahra and George (2002), and Jansen (2005) posited that realized absorptive capacity is likely to influence performance through product and process innovation. Transformation, for instance, facilitates the combination of knowledge and the development of new perceptual schemas and proposals for changes to existing products, processes, and technologies (Jansen, 2005). In addition, exploitation underlying a unit's realized absorptive capacity converts knowledge into products, services, and technologies. In this way, a firm's realized absorptive capacity is vital to a unit's innovation process and contributes to both exploratory and exploitative innovations, as posited by Jansen (2005).

Transformation and exploitation processes may be aimed at deepening existing knowledge and skills, and improving efficiency (Jansen, 2005). In this way, realized absorptive capacity helps organizational units to create refinements to existing processes (Zahra & George, 2002) and to reduce associated costs (Jansen, 2005). Additionally, realized absorptive capacity may also be aimed at developing and applying newly acquired external knowledge to pursue exploratory innovations (Jansen, 2005). Exploratory innovations originate from combining and interpreting existing and newly acquired external knowledge in a different manner (Henderson & Clark, 1990; Kogut & Zander, 1992). Thus one can argue that realized absorptive capacity is positively associated with its exploitative as well as exploratory innovation. As we mentioned earlier that the balance between exploration and exploitation is ambidexterity which leads us to posit that realized absorptive capacity leads to ambidexterity.

Proposition 2a: Realized absorptive capacity, through its ability to transformation and exploitation of external knowledge positively affects ambidexterity

Apart from the contribution of realized absorptive capacity toward explorative innovation (exploration segment of ambidexterity), Jansen (2005) argued that potential absorptive capacity becomes critical to renew a firm's knowledge stock, and develop innovative outcomes that differ substantially from existing products, services, and technologies. Explorative innovations are radical innovations place a sizeable premium on assimilative ability of new external knowledge (Henderson and Clark, 1990; Jansen, 2005). Assimilative ability of external knowledge is an attribute of potential absorptive capacity (Zahra and George, 2002). Because exploratory innovations require new knowledge or departure from existing knowledge (Levinthal & March, 1993; McGrath, 2001), the acquisition and assimilation of new external knowledge contributes to a firm's ability to pursue exploratory innovations (Jansen, 2005). Conversely, without applying newly acquired and assimilated new external knowledge, organizational units are not able to pursue exploratory innovations successfully, as posited by Jansen (2005). Thus a firm's potential absorptive capacity positively moderates the impact of realized absorptive capacity on exploratory innovations. Although, potential absorptive capacity may increase newly acquired external knowledge, Jansen (2005) argued that exploitative innovations build on existing knowledge and are outcomes of deepening and broadening existing knowledge and skills. The development of a firms' potential absorptive capacity, therefore, may hinder the efficient transformation and exploitation of knowledge (Jansen, 2005). Speaking differently, organizations when increase their potential absorptive capacity, decrease the impact of realized absorptive capacity on exploitative innovations. From an intraorganizational standpoint the several aspects of coordination, system and socialization capability that increases potential absorptive capacity, runs counter to realized-absorptive capacity. Also, to increase potential absorptive capacity organization needs low formalization and high diverse networks, with moderate centrality, whereas for realized absorptive capacity one needs diverse networks under

the lens of high formalization with high centrality. Resources for acquisition and assimilation of new knowledge (for exploration) are different for exploitive innovations where one needs resources for with improvements to existing products, services, and technologies. In this sense, Jansen (2005) argued that organizations that increase their potential absorptive capacity may hinder organizational tasks or operations to efficiently develop exploitative innovations. Therefore, potential absorptive capacity negatively moderates the relationship between realized absorptive capacity and a unit's exploitative innovations. Combining the moderation effect of potential absorptive capacity on the effect of realized absorptive capacity on exploration and exploitation we get:

> *Proposition 2b: Potential absorptive capacity moderates the relationship between realized absorptive capacity and ambidexterity. Such that, potential absorptive capacity positively moderates and negatively moderates the relation between realized absorptive capacity on exploration and exploitation respectively.*

Absorptive Capacity, and IT based knowledge Capability

Malhotra et al. (2005) have identified two types of information systems that can enhance absorptive capacity: one that enhances the ability of a firm to absorb (through capture and retention such as organizational memory systems, databases, knowledge repositories) and another that enables a firm to digest (through processing) information received from supply chain partners to create new knowledge (such as interpretation systems, data/text mining tools). Such systems compare incoming information with existing insights, and help in the generation of new insights by integrating or synthesizing information (Scott 2000; Alavi and Leidner 2001). Putting Malhotra's work in terms of Zahra and George (2002) we can posit that, type of ability that helps firm to absorb helps in enhancing potential absorptive capacity, while the ones that helps in digesting helps in realized absorptive capacity.

Malhotra et al. (2005) also provide support for interpreting information based on task characteristics (Becarra-Fernandez and Sabherwal 2001) and individual cognitive styles

(Markus 2001), resulting in an increase in the absorptive capacity of a firm. Therefore, IT can help enhance a firm's absorptive capacity not only by lowering the barriers of bounded rationality, but also by facilitating organizational learning of both tacit and explicit knowledge. IT can play an important role in building a firm's absorptive capacity by providing skills and processing abilities that can support acquisition, assimilation, transformation, and exploitation of knowledge to create innovation (Alavi and Leidner 2001; Holsapple and Joshi, (2000), Holsapple and Joshi, (2002); Dehning et al. 2003). While, acquisition and assimilation are elements of potential absorptive capacity, transformation and exploitation are surrogates of realized absorptive capacity

Further, according to Boynton, Zmud and Jacobs (1994), absorptive capacity can be measured with (a) managerial IT knowledge of business process, and value of IT, (b) Managerial IT process effectiveness. Now managerial IT knowledge and IT process effectiveness are both functions of IT capabilities. Thus, IT based knowledge capability is an antecedent to absorptive capacity.

Thus we propose,

Proposition 2c: IT-based knowledge capability positively affects a firms potential absorptive capacity

Proposition 2d: IT-based knowledge capability positively affects a firm's realized absorptive capacity

Absorptive Capacity and Commercialization of Innovations

Absorption limits provide impetus for firms to develop internal R&D capabilities. R&D departments then not only perform their work along with lines with which they are already familiar, but also they can extend their work to include new ideas and, in particular, incorporate new knowledge that is external to the firm. Chen (2004) examined the effects of knowledge attributes, alliance characteristics, and firm's absorptive capacity on the performance of knowledge transfer. His findings suggest that knowledge transfer performance is positively

affected by the explicitness of knowledge and a firm's absorptive capacity, and that trust and adjustment have positive effects while conflict possesses a curvilinear effect on knowledge transfer performance. Cohen & Levinthal (1990) argued absorptive capacity enables firms to predict more accurately the mature and commercial potential of technological advances. In other words, a higher absorptive capacity and/or efforts to increase absorptive capacity can both promote innovation within a firm as well as a firm's ability to manage innovation effectively. In fact Jansen (2005) mentioned that realized absorptive capacity converts knowledge into products, services, and technologies. By the combination of potential and realized absorptive capacity firms increase the distinctiveness of their innovations (Yli-Renko et al., 2001) and are able to develop new innovations that differ substantially from existing products, services, and processes. Both inward and outward absorptive capacity can increase the ability to commercialize innovations. For instance, as Clark and Fujimoto (1987), Cohen and Levinthal argued (1990), the overlapping interfaces between design, manufacturing, sales and marketing in Japanese firms led to increased absorptive capacity leading to movement of the product from design, sales to market. In sense of outer absorptive capacity, networks between firms and innovation engines, increase the ability to commercialize, as innovators can view their innovations as finished products and firms can sense business value of fundamental research. Nokia has done exactly that with its networks with the academia (Brikinshaw and Gibson, 2004).

In our definition of ability to commercialization of innovations, we included organization's ability to recognize current and emerging markets as a fundamental component. Absorptive capacity is the limit to the rate at which a firm can absorb scientific or technological information. Without being cognizant on absorbing scientific of technological innovations, it is impossible to visualize a market for such innovations. Thus, without absorptive capacity the fundamental requirement to commercialize innovation will not be reached. This leads us to propose:

Proposition 2e: Higher absorptive capacity increases a firm's ability to commercialize innovations.

Implications and Future Research

This work has the potential to make a significant contribution to literature on IT and Firm performance. It extends the theory and our understanding of the relationship between IT investment and firm performance by highlighting the important role of absorptive capacity, ambidexterity and commercialization of innovation that has been overlooked or underrepresented in the existing IS literature. In addition we believe that this work can also add lens to literature on management, strategy and innovation where these constructs were studied but not in the light of strengths and opportunities brought by IT- based knowledge capabilities.

The knowledge-based integrative perspective used in this study is much needed in today's environment where competition becomes a learning race while knowledge base is increasingly complex and wide-spanning across many organizations in the industry. Our model will not only provide a more nuanced understanding of the role IT plays in impacting firm performance, but it might also provide a better explanation for the mixed results regarding the aforementioned relationship between IT investment and firm performance.

From the standpoint of the practitioner this paper compels to ask few key questions. Organizations must ask whether the IT resources can create and enhance a firm's absorptive capacity, which increases a firm's ability to realize market opportunities of innovations within and outside the firm. Increasing absorptive capacity leads to balancing between creation of new markets without hampering the existing ones. Such a balance, alongside absorptive capacity leads to commercialization of innovations.

One of the biggest limitations of this paper is we are treating ambidexterity and absorptive capacity as two distinct constructs with no overlap. Although we have identified the causal relationships between the two constructs, but for matter of theoretical simplicity we are treating them as distinct. Also for theoretical simplicity, we have treated networks as one whole

entity, while discussing its contributions on commercialization of innovations. Further, in this model we are not considering the impact of environmental turbulence, environmental complexity and industry maturity on commercialization of innovations. No matter how integrated IT resources are, the impact of absorptive capacity and ambidexterity in commercializing innovations is through these macro economic variables. So organizations must align its resources to get the best fit considering the environmental turbulence, and industry maturity.

Before these or any other lessons can be acted on with confidence, much research remains and we hope that this paper sets forth a useful path for research in this area. We hope that from the academic standpoint this paper sets a path for research in this area. Each of the proposition posited in this paper is would open doors for future research. This paper opens opportunity for research in both positivist and interpretivist paradigms. Surveys or secondary data could be used to do positivist research, while detailed case studies may aid in attaining interpretevist style of research. Future research must break the constructs into more testable variables and breaking the proposition into hypotheses and test them. Detailed studies could be made in studying specific relations between constructs and brief snapshots on the entirety of the theory. Attempt should be made to integrate all the studies and see how it fits within the bigger picture.

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