

# **A FRAMEWORK FOR ASSESSING THE RELATIONSHIP OF IT COMPETENCE AND INNOVATIVENESS**

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## **ABSTRACT**

One of the recent information technology (IT) research directions has been moving forward to the discussion of enterprise intangible and/or strategic issues. Although IT facility itself is tangible, it can generate enormously intangible returns if it is properly used. In this paper, we propose an integrative model that links strategic issues to IT competence and innovativeness. We examine IT competence in a dynamic perspective to see how it can promote innovativeness. By joining the mediator effects of information synergy and information responsiveness, we propose a conceptual model on how IT competence can facilitate innovativeness via information synergy and information responsiveness. Additionally, a number of propositions are discussed to strengthen our viewpoints.

**KEYWORDS:** IT competence, dynamic capabilities, innovativeness, information synergy, information responsiveness

## **INTRODUCTION**

IT competence can be viewed as an important factor to promote a firm's performance. Researchers conducting IT value studies usually consider explicitly identifying the appropriate boundaries or limits of the impacts to be investigated. (Chan 2000) Prior studies use IT investment as a measure to examine IT value (Thatcher and Oliver 2001; Sircar etc. 2000; Sriram and Krishnan 2003; Im etc.2001; Ryan and Harrison 2000; Kim etc. 2000). This approach underestimates some complex issues, such as the IT investment accounts for the initial price of the hardware, however, the price of hardware facilities decreases at a rapid pace. Furthermore, the amount of IT expenses might include some obsolete equipment which provides no productivity due to the fast variation of IT specifications. On the other hand, using some financial measurements as a firm performance index fails to account for the dynamic nature of organizations, including feedback loops. If IT evaluation approaches are designed with static, closed perspective, they might be inadequate.

Brynjolfsson (1993) provides four possible explanations for the IT productivity paradox, which includes mismeasurement of inputs and outputs, lags due to learning and adjustment, redistribution and dissipation of profits and mismanagement of information and technology. The inconsistency phenomenon exists between the service and manufacturing industries; while there is positive impact on output and productivity of IT adoption in the manufacturing sector, there are insignificant results in the service sector. This is because the intangibles, such as better responsiveness to customers and increased coordination with suppliers, are hard to measure and do not always increase the amount of financial outputs, e.g. firm's ROI or ROA.

Many researchers examine the role that IT plays in promoting collaboration and information sharing both inside and across organizational boundaries. (Lind and Zmud 1995, Pickering and King 1995, Quinn, Anderson, and Finkelstein 1996) Instead of using a financial measurement to indicate the firm's performance, this research focuses on using information synergies and information responsiveness as the main IT effectiveness index. The more information sharing that exists in the organization, the more flexible and creative the organization will be. Therefore, information synergies and information responsiveness might induce the innovation process in an organization. The innovation capability of an organization is one of its competitive advantages, and, from this point of view, we can examine the firm's innovation capability indirectly from the involvement of information synergies and information responsiveness in an organization.

McAfee (2003) identified five pitfalls of IT implementation: inertia, resistance, misspecification, misuse, and nonuse. He mentioned that typical checklist items can not differentiate one process-enabling implementation from another. From the above findings, we can see the importance of management issues when implementing IT. Some companies might adopt the same ERP system, e.g. SAP, but not all of them will be successful after implementing the "best practice" system. However, though the IT system itself is easy to copy, a successful implementation process is difficult to imitate. Furthermore, even if a company adopts the same implementation process as another successful company, it could still fail because it might encounter inner and outer environments which are different from the successful company. Therefore, beyond the typical checklist items, McAfee raised some points, including level of project leadership, management style, project scope, project timing, organization preparation, which should be noticed.

Our motivation for this research is to examine the conditions under which IT competence, from the dynamic capability perspective, can generate information synergy and innovativeness. The past study showed that firms can link the performance of organizations to resources and skills that are firm-specific, rare, and difficult to imitate or substitute (Barney, 1986, 1991). Duguid (1998) also points out, "IT geared toward creating organizational synergies can aid in the delivery of needed resources by removing the physical, spatial, and temporal limitations to communication." IT promoting information synergy can be an approach to facilitate innovation. The purpose of this research is to examine the theoretical model of the IT competence and innovativeness in a dynamic capability perspective. Comparing to prior research, we build a new vision to view digital option, agility and entrepreneurial alertness as the IT competence and link IT to firms' product and organizational innovativeness.

## **IT COMPETENCE**

Ross, Beath, and Goodhue (1996) defined IT competence as "the ability to control IT-related costs, deliver systems when needed, and effect business objectives through IT implementations." From this point of view, a firm would not be successful simply because it implemented a leading edge IT application, but rather because it has developed a capability for applying IT to changing business opportunities. Based on Hamel and Prahalad's theory (1994), Brown and Sambamurthy (1999) defined capability as "the distinctive organizational skills for combining available resources and sustaining superior performance". Thus, by the same token, IT competence can be referred to the distinctive assets and competencies, knowledge, processes, and relationships that enable firms to effectively acquire, deploy, and manage IT products and services in shaping innovations and business strategies. (Feeny and Wilcock, 1998; Beath and Goodhue, 1996; Sambamurthy and Zmud, 1997) Sambamurthy

(2000) also pointed out that IT differentiation is moving toward a new logic, i.e. from the traditional logic of Chamberlinian theory of heterogeneity of firm resources to the new logic of dynamic capabilities of the firm. As for the IT application, it moves from the strategic IT application and unique firm resources toward IT competence coupled with business assets and competencies, process, knowledge and relationship.

## **A DYNAMIC PERSPECTIVE ON IT COMPETENCE**

Bharadwaj (2000) took the resource-based perspective and defined IT competence as “a firm’s ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities.” Bharadwaj divided IT-based resources into three categories which are IT infrastructure, human IT and IT-enabled intangibles. Recent studies examine the IT competence with a resource-based perspective. (Mata 1995, Bharadwaj 2000, Dehning 2003) Within the resource-based perspective, the firm is regarded as a collection of hard-to-copy resources and capabilities and the existence of isolating mechanisms as the fundamental factors of firm performance. (Penrose 1959, Wernerfelt 1984) Resource-based theory emphasizes that firms are heterogeneous, unique, and difficult to imitate, while dynamic capabilities theory (Teece etc. 1997) intensifies the renewed competences. In order to exploit existing internal and external firm specific competences to address a changing environment, the “dynamic capabilities” approach emphasizes the development of management capabilities, and difficult-to-imitate combinations of organizational, functional and technological skills. It can integrate the research areas such as the management of R & D, product and process development, technology transfer, intellectual property, manufacturing, and organizational learning. This paper tries to inspect IT competence in a dynamic capabilities perspective.

Teece (1997) provides three dimensions, process, position, and path, which can help to determine a firm’s distinctive competence and dynamic capabilities. Adopting from Teece’s classification scheme, key IT competence is classified in the following order:

First is the process dimension. Davenport (1998) using opinions from CEO’s practices, which lead us to believe that competitive advantage might just come from doing the best and cheapest job at implementing SAP. On the contrary, it is not worthwhile to invest high IT cost in order to customize the system to fit the original business process. In fact, the SAP system is valuable in its “best practice” business process once firms customize the system, and they can not gain benefit through process reengineering from the system. The unique IT competence does not mean the system itself but the implementing process and know-how capabilities. Though firms install the same ERP systems among them, some are successful while others not. Those who believe that firms will gain advantage by adopting SAP without deep consideration have the general IT competence.

The second is the position dimension. We can examine it through technological assets, complementary assets, financial assets, structural assets, institutional assets, market assets, etc. The existing IT tools in a firm can vary greatly at any given time. Though a single system can not differentiate the distinctiveness, the IT tools portfolios are not the same between firms. Some firms might adopt PDM (product data management) systems to expedite the new product development as the key factor of their competitive advantage, while others adopt CRM (customer relationship management) systems as their most important tool. Furthermore, some firms might adopt the whole modules of SAP, while others might use the HR (human resource) module from PeopleSoft and financial module from SAP. Therefore, the capabilities of positioning information systems to leverage other complementary resources, such as adopting

different modules from different systems, are essential.

The third item is the dimension of path dependence. Firms must follow a certain trajectory or path of competence development. The timing of adopting a new IT tool is an important concern to a firm. First movers do not necessarily gain the most benefits. For example, IT infrastructure is the most expensive investment among IT expenses. The first firm that switches its network backbone to Gigabit (Ultra Fast Ethernet) might spend twice as much as the second firm. The first firm might endure the risk of an unstable new network and cannot balance between cost and benefit. On the other hand, firms must invest in complementary resources and transform their old accumulated resources (such as technical platforms, databases, and legacy information systems) to the Internet before investment in this relatively new technology becomes productive (Zhu and Kraemer 2002). As a result, the capability to change an existing IT infrastructure to a new one at the right time is momentous.

Carayannis (1999) develops an organization knowledge management (the organizational cognition spiral) and tool (the organization knowledge net) to foster synergies between IT and managerial and organizational cognition. By applying the dynamic IT competence, the organizational learning occurs when the new behavior is replicated through the firm. The connectivity and interactivity paths are raised to follow along this “journey to knowledge and self-awareness”. The connectivity path is enabled by IT and is the most frequent path followed by organization since it is a more straightforward way than the efficiency-driven path. However, the interactivity path is enabled by information socio-technologies and its emphasis is on effectiveness.

Below are some definitions of IT competence from a dynamic perspective:

Table 1 Illustrative Examples of IT competence

| IT competence           | Descriptions  | Sources of ideas   |
|-------------------------|---|--|
| IS/Line partnering      | the development of collaborative and harmonious relationships between IT and business managers that enable the sharing of innovation risks, joint ownership of initiatives, and sharing of relevant knowledge | Brown and Sambmurthy (1999)<br>Feeny and Wilcock (1998)<br>Ross, Beath, and Goodhue (1996) |
| Process adaptiveness    | the ability to implement flexible business processes that take advantage of IT functionalities and enhance cost efficiencies, cycle time, and effectiveness.  | Brown and Sambmurthy (1999)<br>Sambamurthy and Zmud (1997)                                 |
| Value innovation        | Envisioning how novel combination of strategic business levers (assets and competencies, processes, relationships, and knowledge) could be realized through IT and thus promote IT-based business innovation  | Bharadwaj et al. (1999)<br>Brown and Sambamurthy, (1999)<br>Feeny and Wilcocks (1998)      |
| Knowledge work leverage | Developing collaborative and harmonious relationships between IT and business managers so as to enable the sharing of knowledge   | Brown and Sambamurthy (1999)<br>Feeny and Wilcocks (1998)                                  |

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and innovation risks and the joint ownership of technology-based initiatives Ross, Beath, and Goodhue (1996)

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Adapted from Sambamurthy (2000) and Sambamurthy and Zmud (2000)

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From the definition of IT competence by Sambamurthy (2003): “IT competence is the organizational base of IT resources and capabilities and describes a firm’s capacity for IT-based innovation by virtue of the available IT resources and the ability to convert IT assets and services into strategic applications”. Sambamurthy proposed a theoretical perspective to highlight three important dynamic capabilities: digital options, agility, and entrepreneurial alertness.

### DIGITAL OPTIONS

Sambamurthy (2003) applies the real option theory to redefine the role of IT as a digital options generator. Real option theory gives a chance for firms to position themselves to seize emergent opportunities. Sambamurthy also combines the dimensions of reach and richness raised by Evans and Wurster (2000). In our research, we adopt Sambamurthy’s study of digital options as a set of IT-enabled capabilities in the form of digitized enterprise work processes and knowledge systems. There are four types of digital options defined by Sambamurthy:

1. Digitized process reach: The extent to which a firm deploys common, integrated, and connected IT-enabled processes, the salient information technologies include enterprise resource planning, supply chain management, customer relationship management, product data management
2. Digitized process richness: Quality of information collected about transactions in the process, transparency of that information to other processes and systems that are linked to it, and the ability to use that information to reengineering the process, the salient information technologies include decision support, analytic, and tracking technologies
3. Digitized knowledge reach: Comprehensiveness and accessibility of codified knowledge in firm’s knowledge base and the interconnected networks and systems for enhancing interactions among individuals for knowledge transfer and sharing. The salient information technologies include intranets, databases, and knowledge repositories
4. Digitized knowledge richness: Systems of interactions among organizational members to support sense-making, perspective sharing and development of tacit knowledge. The salient information technologies include advanced knowledge technologies, virtual vide-conferencing systems, collaborative tools for knowledge sharing, etc.

### AGILITY

Agility is the ability to find opportunities for innovation and catch those competitive market opportunities by assembling necessary assets, knowledge, and relationships with speed and surprise. (D’Aveni 1994; Goldman et al. 1995) There are three types of agility defined by Sambamurthy (2003): customer, partnering and operational agilities. The role of IT in customer agility is to build and enhance virtual customer communities for product design, feedback, and testing. The role of IT in partnering agility is to facilitate inter-firm collaboration, such as collaborative platforms and portals, supply-chain systems, etc. The role of IT in partnering agility is the technologies for modularization, and integration of business processes.

### ENTREPRENEURIAL ALERTNESS

Entrepreneurial alertness is the capability of a firm to discover its marketplace, identify areas of marketplace ignorance, and verify opportunities for action. (Sambamurthy, 2003) Strategic foresight and systemic insight are two capabilities of entrepreneurial alertness. Strategic foresight is the ability to anticipate discontinuities in the business environment and the information technology space. It includes an integrated application of IT and business opportunities in the consideration of competitive actions. Systemic insight is the ability to visualize connections between digital options, agility capabilities, and rising market opportunities in building competitive actions.

## **INFORMATION SYNERGY**

Information synergies are the performance gains that result when IT allows two or more individuals, or subunits, to pool their resources and cooperate and collaborate across roles or subunit boundaries. It is a between-person or between-group effect. (Dewett and Jones 2001) Competitive advantages allied with synergy are less likely to be imitated, as they are often attained under a distinctive set of circumstances and on the basis of firm-specific resources. (Bharadwaj et al. 1993) IT can be a tool to impact organizational functioning through the effect of horizontal coordination. IT can also link employees in new organizational forms, such as the virtual organization. (Nohria and Berkley 1994) However, the use of IT is not a panacea. Without the human factor, IT is just an equipment, therefore, Davenport (1994) promotes the insight of a human-centered information management. An enterprise system should impose its own logic on a company's strategy, culture and organization. (Davenport 1998) Therefore, all members in the organization are willing to utilize the IT platform since the information system is designed for the community. On the contrary, the worst thing a firm can do is to make a decision about a system based on technical criteria instead of human concern. Even in a firm adopting the newest IT, people might be reluctant to use the information system.

Firms integrate IT in their operations by reengineering their intra-organizational and inter-organizational business processes, theoretically, a rich communication and synergy must develop between business partners (Raymond and Blili 2000-1). Rowley (2002) also raises the essential issue of synergy by viewing the extent of integration between the functions and multiple channels. IT can carry out the environment of a virtual community which facilitates and enhances the activities of the community in a way that could benefit it as a whole. In other words, the information flowing through the network provides opportunities for the creation of synergy within the community.

Coordination theory suggests that managerial judgments and actions across the enterprise can be linked through the use of a variety of coordination mechanisms. (Galbraith 1974) The IT tool can be a good platform to use as a coordination mechanism, such as the Enterprise Information Portal, Document Management System, Knowledge Community, Collaboration system, e-learning system, etc. The implementation and use of these coordination mechanisms can promote values of coordination and partnering. (Brown and Sambamurthy 2001) Furthermore, Van De Ven (1986) suggests that the best way of managing complexity associated with the innovation process is to create synergy by involving the best-qualified people to perform certain specific tasks and then to consolidate their activities to establish a certain redundancy. Hence, a proposition is proposed as follow:

**Proposition 1: Firms with IT capability that are able to capture the rare, unique, hard to copy characteristics dynamically in digital options, agility, entrepreneurial alertness**

**dimensions will positively influence the extent of information synergy.**

## **INFORMATION RESPONSIVENESS**

Information responsiveness is the ability of a company to gather information from its commercial environment and within the organization, furthermore, to detect and anticipate changes. If people in a company respond others' information quickly and often, it may be that they have the skills and competences to be able to exchange accurate and helpful information, thereby building belief in their ability. Thus, information responsiveness might increase the perception of cooperative intentions. (Ridings, 2002; Gefen, 2002) Hence, we propose the following propositions:

**Proposition 2: Firms with IT capability that are able to capture the rare, unique, hard to copy characteristics dynamically in digital options, agility, entrepreneurial alertness dimensions will positively influence the extent of information responsiveness.**

## **INNOVATION AND INNOVATIVENESS**

Myers and Marquis (1996) define innovation as “a complex activity which proceeds from the conceptualization of a new idea to a solution of the problem and then to the actual utilization of economic or social value.” Innovation represents the commercialization of new technologies or technological change (Utterback and Abernathy 1975). When a firm's technology development activities are constrained, its innovation efforts will likewise be limited. (Penrose 1959) Garcia and Calantone (2002) provide a definition which captures the essence of innovations from an overall perspective: “Innovation is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention.”

Innovativeness is most frequently used as a measure of the degree of “newness” of an innovation. (Garcia and Calantone, 2002) Innovativeness can be defined as “an enduring organizational trait”. (Subramanian, 1996) From the above definitions, we know that product innovativeness is not equal to firm innovativeness. Firm or organizational innovativeness has been defined as the propensity for a firm to innovate or develop new products. (Ettlie, Bridges, O'Keefe, 1984) In other words, organizational innovativeness can be viewed as the propensity for a firm to adopt innovations. Therefore, the innovativeness of a product that a firm markets or adopts is not a measure of organizational innovativeness. For example, Microsoft is often viewed by its competitors as a great imitator instead of a highly innovative company. Owing to above analysis, we adopt innovativeness from two perspectives in this study: product and organization.

From the product perspective, innovativeness is most frequently used as a measure of the degree of “newness” of an innovation. That is, highly innovative products can be regarded as a high degree of newness. From the macro and micro perspectives, Garcia and Calantone (2002) give definitions of these two dimensions: “From a macro perspective, innovativeness is the capacity of a new innovation to create a paradigm shift in the science and technology and/or market structure in an industry. From a micro perspective, innovativeness is the capacity of a new innovation to influence the firm's existing marketing resources, technological resources, skills, knowledge, capabilities, or strategy.” In our research, we adopt this definition of micro

perspective to examine how information synergy influences the level of innovativeness within a firm. Findings from Olson's (2001) research demonstrate the importance of cooperation between marketing, operations, and R&D departments and vary by time and the level of innovativeness.

The time issue in the innovation process becomes the most challenging parameter in the competitive market. The sooner a new product is developed, the more the competitive advantage will gain. Therefore, a rapid product development (RPD) technique should be applied in the R&D department in a firm. RPD requires team-oriented communication systems, which open up new ways of cooperation. By combining these technologies within an R&D organization effectively, the product development time can be reduced effectively. (Bullinger, H.J. etc. 2000) As a result, building up an environment for information sharing helps to expedite the efficiency and effectiveness of an innovation process.

From the organizational perspective, innovativeness can be defined as "an enduring organizational trait". (Subramanian, 1996) Therefore, truly innovative organizations will exhibit innovative behavior consistently over time. In addition, innovativeness is considered to be an integral dimension of organizational strategy. There are two types of organizational innovativeness, which includes technical and administrative innovativeness. As an organization become larger, the administrative innovations will enhance coordination. (Subramanian, 1996) In the mean time, the extent of information synergy and information responsiveness will influence the level of innovativeness. Hence, we propose the following propositions:

**Proposition 3-1: The relationship between IT capability and innovativeness is mediated by information synergy.**

**Proposition 3-2: The relationship between IT capability and innovativeness is mediated by information responsiveness.**

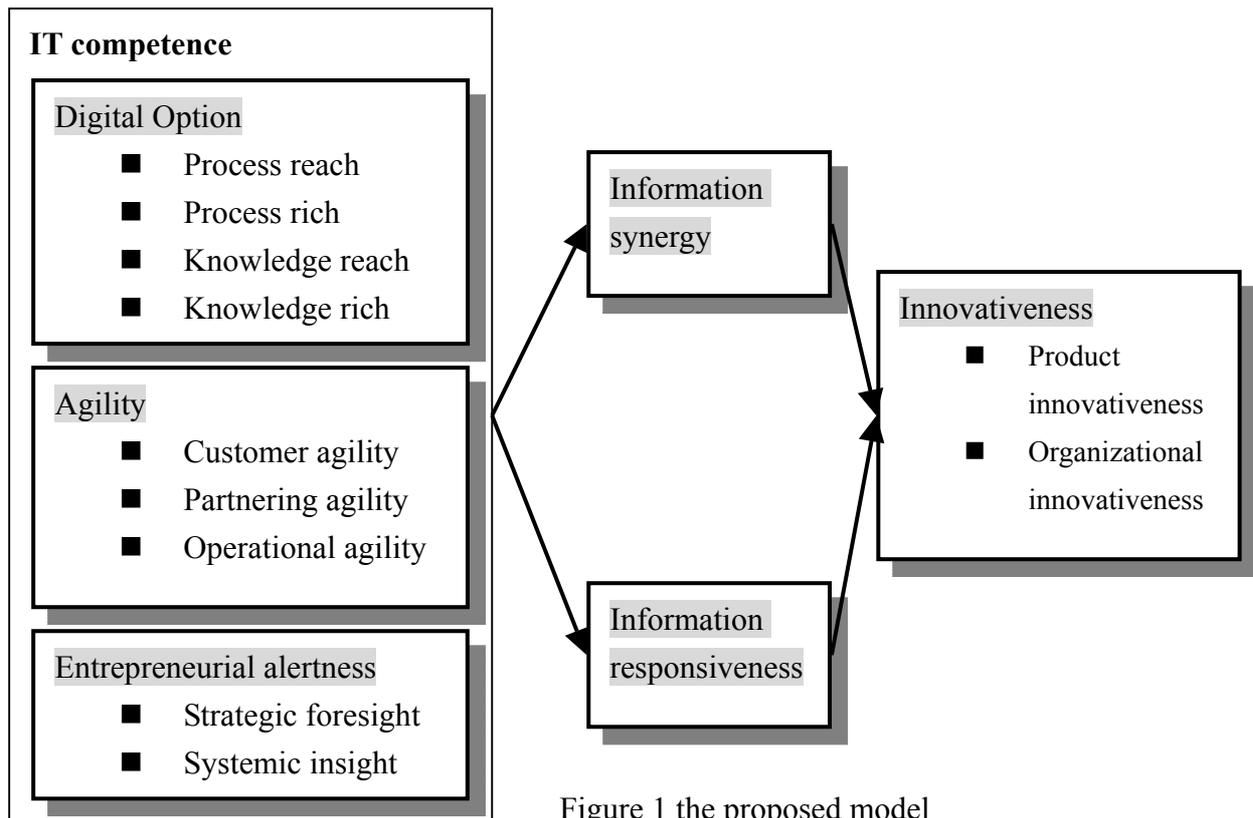


Figure 1 the proposed model

## SUMMARY AND CONCLUSIONS

Though IT itself is a tangible technology, it can generate enormously intangible return if it is properly used. In this research, we try to view IT as a dynamic capability to promote firms competency instead of implementing IT in a static way. Therefore, we do not use IT investment as an index to evaluate IT competence. In other respects, we employ a dynamic capability perspective to emphasize the value of increasing return in the age of knowledge economy rather than the decreasing return in the industrial age.

Many prior researches emphasize the importance of IT competence, while they use IT investment to be a measurement variable. The IT investment measurement itself cannot reflect the dynamic IT competence in the changing business environment; therefore, our research provides several academic contributions:

- First, we present a theoretical model to examine IT competence in a dynamic way.
- Second, we build a new vision to view digital option and agility as the IT competence and link IT to firms' product and organizational innovativeness.
- Third, by combining the mediator effect of information synergy and information responsiveness, we raise the importance of information synergy and information responsiveness which IT competence generates.

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