

2005

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Recommended Citation

Tarafdar, Monideepa and Gordon, Steven R., "How Information Technology Capabilities Influence Organizational Innovation: Exploratory Findings from Two Case Studies" (2005). *ECIS 2005 Proceedings*. 17.
<http://aisel.aisnet.org/ecis2005/17>

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HOW INFORMATION TECHNOLOGY CAPABILITIES INFLUENCE ORGANIZATIONAL INNOVATION: EXPLORATORY FINDINGS FROM TWO CASE STUDIES

Abstract

This paper is based on research-in-progress that examines how a firm's information technology (IT) capabilities affect its ability to innovate. Prior research has identified five dimensions of IT capability and three activities related to innovation. The current research draws on these themes and examines the interplay among these factors. We used a multiple case study method and studied innovation activities at three case sites. The findings so far have revealed that the different aspects of IT capability do indeed affect an organization's ability to innovate and influence the innovation process in different ways. The paper explains how and why this is so, and identifies areas for further enquiry.

Keywords: IT capability, Innovation, IT infrastructure, qualitative research

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INTRODUCTION

Many IT researchers and practitioners firmly believe that IT is an enabler of innovation. Innovation leaders often have a much different perspective. They have battled with their IT organizations' fixations on standardizing and automating processes. To them, IT is an anathema to creativity and a barrier to innovation. The purpose of this research is to understand how IT capability influences organizational innovation and, by extension, to learn what IT capabilities a firm should have and how these capabilities should be used to best support and encourage innovation.

A great deal of empirical and anecdotal evidence exists to support the contention that innovation is one of the primary drivers of firm growth and profitability (see, for example, Giarratana, 2004, Seaden et al 2003, Roberts 2001, Grupp & Maital 2000, Jonash & Sommerlatte 1999, Acs & Audretsch 1990, Katsuhito 1984). Many CEOs, either aware of this research or instinctively believing that their organizations' success depends on innovation, make innovation a strategic imperative (Nambisan, 2002, Hay & Kamshad 1994), often incorporating a mandate for innovation into their organizations' mission statements. Not surprisingly, many researchers have explored the antecedents of innovation, hoping to determine what a firm must do if it hopes to become more innovative (Hult et al 2004, Blazevic & Lievens 2004, Amar 2004, Hadjimanolis 2000, Warren et al 2000, Scott & Bruce 1994). In many cases, this research explicitly addresses how information technology (IT) is developed into the innovative product or process under study, and how emerging IT is often used for leading edge innovation in products and processes. In other cases, IT seems to be ignored entirely as an antecedent to innovation.

Studies (Farrel 2003, Wheeler 2002, Zahra 2002) also suggest that the role of IT is to drive and lead business strategy formulation, and concur that IT is a means to achieve growth and create and sustain competitive advantage. In other words, the existence of IT capabilities and IT leadership within the industry are antecedents to industry leadership. In this context, researchers (Sambamurthy et al 2003, Wheeler 2002) have called for a need to understand the routines and processes through which IT capabilities help organizations to innovate and create competitive advantage. An understanding of how this happens would have important implications for appropriately developing and leveraging relevant IT capabilities. It would also help to better understand how IT capabilities can be used to formulate IT mediated strategies. In this context, there have been studies which have investigated the effect of IT investment on firm performance such as profits, productivity and customer value (Barua & Mukhopadhyay 2000, Brynjolfsson & Hitt 1996). A recent study (Bharadwaj 2000) suggests that a firm's IT capability enables it to achieve higher returns on its IT investments and is associated with higher cost ratios and lower profit ratios. However there have not been any studies that investigate the effect of IT capabilities on an organization's ability to innovate.

LITERATURE REVIEW

In this section we describe the conceptual foundations for our study. We draw from two broad streams of research. The first is based on a resource based view of IT and describes various aspects of IT resources and capabilities. The second stream is based on studies on organizational innovation and describes characteristics of innovation processes.

Information Technology Capability

The phrase "IT capability" describes different aspects of an organization's base of IT resources. These resources influence and determine the organization's ability to convert IT assets and services into strategic applications (Bharadwaj 2000, Sambamurthy & Zmud 1999), and to mobilize and deploy IT based resources with other resources and capabilities. There are five dimensions of IT capability.

1. **IT Infrastructure:** This includes physical IT assets in terms of hardware, software and networks (Broadbent & Weill & St. Clair 1999, Keen 1991) on which systems are built. It provides the technical basis for carrying out IT based product and process innovation. Infrastructure also includes the extent to which the assets are integrated (Bharadwaj 2000, Weill & Broadbent 1998).
2. **IT Human Resources:** These include technical and managerial skills of IS employees, such as programming, systems analysis, network administration, database management, project management, co-ordination and leadership, interaction with use community and effective management of IS functions (Copeland & McKenny 1988). These skills are highly firm specific and difficult to imitate - hence they serve as a source of competitive advantage. (Keen 1991, Mata & Fuerst & Barney 1995)
3. **IT-related Intangible Resources:** Sustained use of IT can lead to the creation of various intangible benefits, which can serve as the basis for additional capabilities. For example, the effective use of CRM systems for tracking customer preferences can increase the customer orientation of the firm (Bharadwaj 2000, Hitt & Brynjolfsson 1996). Similarly, the use of knowledge management technologies can help in knowledge formalization, consolidation and dissemination. This can lead to the creation of inimitable knowledge assets (Quinn & Bailey 1994). IT- enabled sharing of resources can increase the flexibility of different organizational units by eliminating temporal and spatial limitations to communications. IT enabled business process integration with partners can similarly result in close relationships and help in collaborative commerce (Bharadwaj et al 1999).
4. **IT Coordination:** Mulligan (2002) recognizes IT coordination as an independent construct in the measurement of IT capability. Coordination runs the continuum from a low level, in which transaction

processing systems within different functions are independent, to a second level, in which data flows across functions, to a third level described by processing interdependence, work flow, and the use of IT for integrated activities such as CRM.

5. IT Governance: Governance describes the authority, control, and audit in the allocation and delivery of IT resources and services. The existence of IT governance systems has been shown to affect firm profitability and strongly influences the value that an organization generates from IT (Weill & Ross 2004).

The Innovation Process

The innovation process consists of three broad activities, “Initiation”, “Development” and “Implementation” (Damanpour 1991, Zmud 1982, Utterback 1971). The “Initiation” activity involves the decision on part of the organization to adopt an innovation. The impetus for adoption could either be performance related, such as falling market share, losses or loss of industry pre-eminence (Kanter 1982, Tushman & O’Reilly 1997), or internally created as a consequence of a need for proactive business innovation (Nonaka 1988, Tushman & Nadler 1986). The role of gatekeepers and inputs from environmental scanning (Tushman & Katz 1980, Tushman & Scanlan 1981) provide impetus for the “Initiation” activity.

The “Development” activity involves the design and development of product and process innovations planned in the Initiation stage. This stage has activities such as idea generation and problem solving (Tushman & O’Reilly 1997). Information processing is rapid and decision making fast (Eisenhardt & Tabrizi 1995). New information is acquired from competitors (Tushman & O’Reilly 1997) and customers (Drucker 1998), and connected with existing knowledge (Galbraith 1982) to create new products and processes. Information exchange is accomplished through formal means such as cross functional groups, virtual teams and boundary spanning roles (Tushman & Nadler 1986) and through informal means such as diffusion networks (Rogers 1995) and grapevines (Kanter 1982).

The “Implementation” activity involves the implementation of innovations designed as part of the “Development” activity. Process and product redesign leads to changes in different processes and control systems (Davenport 1993). Effective and reasonably strict control systems are required for efficiently accomplishing the administration and co-ordination tasks necessary for implementation of the innovation (Galbraith 1982, Seely Brown 2002).

There are therefore, five aspects to IT capability. Our study investigates how each aspect influences the innovation process.

METHODOLOGY

Existing literature describes in some detail and separately, aspects of IT capabilities and activities associated with the innovation process. However, there are no studies that describe or explain *how* or *why* IT capabilities influence organizational innovation. Considering the lack of explanatory literature in the field and the nature of the research questions, we adopted a qualitative research methodology (Miles & Huberman 1994, Lee 1989) and used case studies (Yin 2003) to collect data. We used the case study method because in order to understand the possible relationships between IT capabilities and innovation, we needed to describe specific organizational contexts of innovation adoption, and analyze the role of IT in them. Accordingly, we used a multiple case methodology- that helped us to identify common patterns from multiple innovation instances from more than one organization, and achieve replicability (Yin 2003, Lee 1989) in our findings. We studied innovation processes in three organizations.

The literature provided guidelines based on which a structured, open-ended questionnaire was used. The questionnaire was divided into three sections. The first section had questions about the general background of the organization and the nature of innovation activities. The second section consisted of questions that addressed the general role and importance of IT within the organization. The third section had questions that addressed the role of specific IT capabilities in the innovation process. Data was collected primarily through face-to-face interviews conducted by the authors. The interviews lasted from 45 minutes to about 2 hours. Details about the companies and data collected have been mentioned in Table 1 below.

In the next section, we describe the findings from *EduCo* and *GlassCo*. At the time of writing, the interviews and data collection at *AutoCo* are in progress.

Organization	Descriptions of people interviewed
EduCo Industry: Service- Higher Education	Chief Executive Officer, Chief Information officer, 3 senior managers in IT, 1 senior functional manager
GlassCo Industry: Manufacturing - Glass	Chief Information Officer, 1 senior manager in the Engineering function, 1 middle manager in the IS function
AutoCo Industry: Manufacturing- Automotive components	Chief Information Officer, 2 senior managers from functional departments, 2 junior/middle managers in the IS function

Table 1. Details of organizations studied

RESULTS

The data revealed that different aspects of IT capability influence the innovation process. We describe the findings, with the help of illustrations from the interview data.

Influence of IT infrastructure: We found that IT Infrastructure influences the innovation process in two ways. First, certain technologies, such as knowledge management systems, can increase the innovation for development teams and support innovative activities by those who might not otherwise be prone to innovate. For example, the role of knowledge management systems was described in the following way by the CIO at GlassCo.

The Engineering group uses CAD software and other domain specific tools for the design of furnaces, materials and the production processes. These tools help in developing technical solutions.

At EduCo, a business unit manager and key innovator noted:

We've just had a failure on a new product [in the Executive Education program]. What did we learn from that experience? What would we do differently the next time we were going to vet a potential partner? Nobody has written that information down. [If the principal movers left], the next time somebody comes up with an idea, you'd start all over again and likely make the same mistakes...

Second, IT infrastructure provides technical capabilities and an overall technical base that can be leveraged while developing innovation solutions. According to the CIO at GlassCo,

We have a solid transaction processing infrastructure in the form of an ERP package. We also have a very integrated and streamlined file structure. This has made it easy for us to develop

and implement our data warehouse. Since the transaction system is good, data can be easily imported and OLAP cubes built. This has been a major enabler in scenario planning and in enabling different relationships between the data to emerge.

At EduCo, the Director of IT Architecture noted,

[We are] putting out new content on a much faster rate than you would have thought on paper, considering the number of people. And, we're hosting on a much greater rate [compared to when hosting was outsourced]. Now we have more capabilities and more content that we've hosted internally without a substantial increase in either footprint or cost.

Influence of IT human resources: We found that IS professionals can enhance the IT awareness of innovation teams through interactions and information exchange, and their awareness of how other companies in the industry use IT. The CIO of GlassCo described this in the following way:

There is an emerging technologies group within the IT organization, whose job it is to monitor new technologies through conferences, training and interaction with industry, vendors and competitors. There is a fixed budget allocated to this activity. We also have IT liaison officers who "champion" new ideas and interface between various functional areas and the IT department, thus enabling IT to support innovation needs of the functional areas.

Our knowledge management team has specialists in different areas. They are familiar with the data and with the business, so they have an idea of what the different processes require. On the whole, our IT department has adapted the company to more sophisticated and involved levels of IT use – they have also increased the overall "digital literacy" by making people familiar with advanced technologies.

At EduCo, the Director of Curriculum Innovation and Technology noted:

[Information exchange for innovation occurs in] two ways – for one, from faculty interactions and working with faculty. And the other part is, we try and write and present at about five or six conferences a year. And so those conferences allow us to see what other people are doing and then adapt it back to the [EduCo] culture – it's a critical piece of outreach.

IT professionals also provide support for problem solving, training and end user education, as described by a liaison officer at GlassCo,

Recently, we developed a factory automation system that integrates all the machines on the shop floor and helped to track different changes in the PLC software on these machines. IT was involved from the very beginning- a lot of hardware had to be installed, along with servers and software configuration that had to be done. Engineering and IT worked closely together to define the parameters of this system.

But, at EduCo, it seems, communication back to end users is not as strong. The Director of Architecture said,

We don't do enough of the education, to be blunt and honest. It's very rare. And this is something we have talked about – to get that knowledge sort of out to the various groups – maybe at their retreats, maybe in staff time, etc. We have done fits and starts of it, but nothing cohesive, and nothing on a continuous basis, which I think is a weakness for us.

Influence of intangible resources: Intangible resources from sustained IT use often take the form of increased customer orientation and enhanced market knowledge. Therefore they add to organizational capabilities for exploration and exploitation of market opportunities.

The CIO of GlassCo described it in this way:

We use knowledge management software for disseminating various solutions. This has resulted in greater “awareness” within the organization as a whole. We also do scenario planning. This exercise goes a long way in determining different product and process innovations.

Influence of IT governance: The “Development” stage requires quick information dissemination and rapid decision-making. Hence the decentralized mode of IT governance, which permits these conditions to exist by vesting line managers and divisional IS executives with decision making authority, is desirable. In contrast, the “Implementation” stage requires a structured program for efficiently accomplishing the technical roll out of the innovation. The centralized mode, which provides a top down systematic approach to IT management, is desirable in this stage.

EduCo has a centralized committee called the IAG (Internet Advisory Group), which includes senior managers from around the community. The IAG examines business cases for IT, prioritizes the funds, and determines how the projects will get done. According to the Director of Architecture,

Pretty much anybody can request a project and [they] do. It’s typically filtered through a senior manager from a department or division either directly to ourselves or to the IAG.

However, the Curriculum Innovation and Technology Group operates outside that process, providing a less centralized form of control. According to its director,

We have different levels of sponsorship. Larger projects tend to come through [the committee of] Deans and Chairs. And then, smaller initiatives can come from any faculty member. And the larger ones get prioritized first. The assumption is that more students will be positively affected by them.

Influence of IT coordination: We found that IT based co-ordination capabilities enabled quick sharing of information across departments and accelerated the adoption of innovations by legitimizing and enabling the sharing of knowledge and perspectives between different departments. A middle manager in the IS department at GlassCo described this in the following way:

The organization has found the intranet very useful for disseminating information in general. Specifically, with respect to innovation, most of the software that we use is net enabled. Also, most applications used in different functions, such as in the distribution center, new product development and engineering, are based on the basic ERP system. Hence there is uniformity of data and information can be easily transferred across departments.

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

Our data from the case studies strongly support the contention that IT capability can affect an organization’s ability to innovate. The evidence we have collected so far, shows how specific IT capabilities have supported specific innovations. In addition, the case study participants are quite clear that the innovations that have taken place could not have taken place had the specified capabilities been absent. We anticipate that the ongoing interviews will reveal further instances of linkages between IT capabilities and the innovation process, and would throw light on which capabilities might be more important for a given activity in the innovation process.

Our sample, however, is too small to make any determination as to which IT capabilities are most critical, in the sense that if they were missing, the organization as a whole would be less innovative. Nor is there enough evidence to indicate whether or not there are decreasing returns to IT capability. Is there, perhaps, some level beyond which additional IT capability has little impact on an organization's ability to innovate? It would also be instructive to compare the IT capabilities of organizations that are less innovative with those that are more innovative to see whether IT capabilities directly affect innovation or act simply as an enabling factor. This research is clearly a first step in exploring the complex relationship between IT capability and organizational innovation.

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