THE EFFECT OF IT CAPABILITIES ON CROSS-FUNCTIONAL CAPABILITIES

Research-in-Progress

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Abstract

Research in both the strategy and information systems (IS) areas has identified capabilities as key to competing effectively in dynamic and turbulent environments. Firms realize benefits by adopting complementary combinations of capabilities. We draw on Grant's hierarchy of capabilities to develop a model that explains how a firm's information technology (IT) capabilities can enhance the intangible value of the firm through their effect on a set of cross-functional capabilities. Using a sample of 394 firms drawn from industry ranking surveys, our preliminary results suggest that some cross-functional capabilities have a positive impact on the long term, intangible performance of a firm as measured by Tobin's q.

Keywords: IT capabilities, cross-functional capabilities, Tobin's q

Introduction

Research in both the strategy and information systems (IS) areas has identified capabilities as key to competing effectively in dynamic and turbulent environments. Firms realize benefits by adopting complementary combinations of capabilities. From a strategy perspective, when the external environment is highly uncertain, the resources and capabilities of the firm provide "a more durable basis for strategy than a definition based upon the needs which the business seeks to satisfy" (Grant 1991). Research in IS has shown that IT capabilities and investments in IT impact a firm's overall performance (e.g., Bharadwaj 2000; Bharadwaj et al. 1999). However, the interplay of IT capabilities with other firm capabilities and the resulting impact on a firm's long term performance remains understudied.

This research-in-progress seeks to answer the following research question: *How does IT capability, a functional capability, support the cross-functional capabilities of a firm to yield intangible value?* We draw on Grant's (1996) hierarchy of capabilities to develop a model that explains how a firm's information technology (IT) capabilities can enhance the intangible value of the firm through their effect on a set of cross-functional capabilities. This paper proceeds as follows. First, we discuss the theoretical perspectives that inform our research model and develop our hypotheses. Second, we discuss our data and methodology. Third, we present our preliminary results. Finally, we discuss the theoretical and practical implications of our preliminary findings.

Theory and Hypotheses

Hierarchy of Capabilities

Drawing on Grant (1991), a firm's capabilities are what the firm is able to do when its resources are working together. Barney (1995) further defines capabilities as all internal attributes of the firm that enable it to work with its partners to deliver products and services to its customers. An understanding of the relationships between the resources, capabilities, competitive advantage, and profitability of the firm is central to the resource-based approach (Grant 1991). A firm's capabilities are fundamental to its overall strategy, are the basis for firm profit, and are what the firm can do as a result of teams of resources working together (Grant 1991).

Grant (1996) defines an overall hierarchy of capabilities that exist within firms. In this hierarchy, lower level capabilities are necessary enablers of higher order capabilities. At the highest level, cross-functional capabilities such as new product development capabilities or customer support capabilities require integration of knowledge across a wider spectrum of the organization. One level below cross-functional capabilities is broad functional capabilities such as marketing capabilities, R&D capabilities, or IT capabilities. Below these capabilities are several more levels of capabilities which require increasingly specialized knowledge. We focus on the top two levels of capabilities in this research-in-progress for two reasons. First, prior research has demonstrated a clear relationship between capabilities and firm performance. However, most research has focused on the relationship of capabilities to tangible, accounting-based measures of firm performance instead of the long term, intangible measures of firm performance. Second, prior research has demonstrated that investments in IT as well as IT capabilities have a positive impact on a firm's profitability. However, extant research has not examined what intervening mechanisms or capabilities exist. As a lower level functional capability that enables the higher level cross-functional capabilities, we examine the relationship between IT capabilities and cross-functional capabilities. We develop these two ideas next.

Cross-functional Capabilities

A firm's capabilities manifest themselves in a variety of business activities. Cross-functional capabilities encompass the greatest breadth and integration of a firm's knowledge to achieve them. We identify four key cross-functional capabilities that have the potential to impact a firm's intangible value – managerial capability, global competitive capability, innovative capability, and product/service quality capability. We draw on the framework proposed by Day (1994) which identifies three categories of firm capabilities: inside-out, outside-in, and spanning to further explain how these capabilities impact the intangible value of the firm.. We expect each of these cross-functional capabilities to have a positive impact on the intangible value of the firm.

Inside-out capabilities are those which work internally to the firm but are triggered in response to changes in the external environment. Examples of these types of capabilities are manufacturing and logistics. We identify managerial capabilities, as a key inside-out capability. Managerial capabilities refer to a firm's ability to build, integrate, and reconfigure organizational resources and competences (Adner et al. 2003). This leads to our first hypothesis:

H1a: *A firm's managerial capability positively influences its intangible value.*

Outside-in capabilities are capabilities that define the firm's relationship with customers and suppliers by monitoring the external environment and sensing changes in the market. Examples of outside-in capabilities are market sensing, channel bonding. We identify global competitive capabilities as a key outside-in capability. Global competitive capability refers to a firm's ability to strive in global environments. This leads to our next hypothesis:

H1b: *A firm's global competitive capability positively influences its intangible value.*

Spanning capabilities are those which bridge inside-out and outside-in capabilities, and depend on both internal and external cues to perform. Examples of spanning capabilities are new product/service development, strategy and formulation. We identify two key spanning capabilities. First, we identify innovative capabilities as a spanning capability. Innovative capabilities refer to a firm's ability to identify and use opportunities to create new products or services (Subramaniam et al. 2005; Van de Ven 1986). This leads to our next hypothesis:

H1c: *A firm's innovative quality capability positively influences its intangible value.*

Second, we identify product/service quality capability as a key spanning capability. Product/service quality capability is defined as the ability of a firm to develop and delivery a product/service to satisfy those preconceived composite wants of the users (Thatcher et al. 2001). This leads to our final hypothesis:

H1d: *A firm's product/service quality capability positively influences its intangible value.*

IT Capabilities

We adopt Bharadwaj's (2000) definition of IT capabilities as the ability of the firm to "mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities." In her study, Bharadwaj (2000) applied the lens of the resource-based view to explain how a firm's IT capabilities influence its tangible, accounting-based measures of performance. She found that firms with superior IT capabilities had higher profit ratios and lower cost ratios thus supporting the notion that superior IT capability will lead to better firm performance. In another study of IT's impact on firm performance, Bharadwaj et al. (1999) found that a firm's investments in IT positively influence the firm's intangible value. While these studies both show that IT capabilities impact the tangible aspects of a firm's performance and investments in IT resources impact the intangible aspects of a firm's performance, the question remains as to whether or not there is some intervening mechanism through which IT capabilities impact firm performance. To address this issue, we draw on Grant's (1996) hierarchy of capabilities. As a lower level capability, IT capability enables the higher level cross-functional capabilities. This leads to our second set of hypotheses:

H2a: *IT capability positively influences a firm's managerial capability.*

H2b: *IT capability positively influences a firm's global competitive capability.*

H2c: *IT capability positively influences a firm's innovative capability.*

H2d: *IT capability positively influences a firm's product/service quality capability.*

Figure 1 presents the research model and hypothesized relationships.

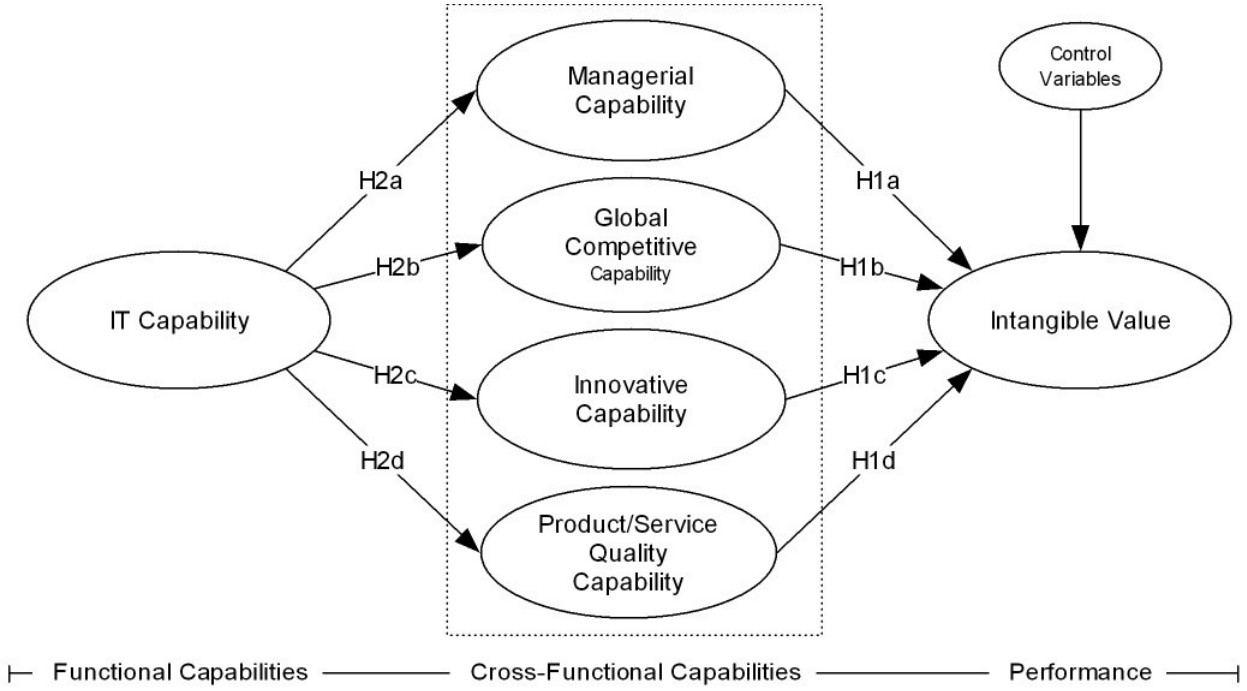

Figure 1. Research Model

Data and Methodology

We draw data from three sources to test our research model: (1) the InformationWeek 500 ranking of most innovative corporate users of IT, (2) the Fortune magazine ranking of most admired companies, and (3) the Compustat database. We used the InformationWeek rankings to identify firms with superior IT capabilities, the Fortune rankings to identify firms with key cross-functional capabilities, and the Compustat database to collect firm and industry-level data for our dependent variables and control variables.

To be included in the InformationWeek rankings, firms must have at least $500 million in annual revenue and complete a survey on their business technology strategies. The surveys are then evaluated by a group of industry analysts, IT executives, IS researchers, and other practitioners to determine the ranking. They are asked to vote for the firms who leverage information technology in the most innovative ways to improve the business rather than merely focusing on the 500 biggest IT spenders. The resulting list is made up of the firms who have successfully launched innovative IT strategies and initiatives or have a strong reputation for being an IT leader (Bharadwaj, 2000). We used the 2009 ranking list which is the year the firms were surveyed to determine which firms in our sample had superior IT capabilities.

We collected the data on cross-functional capabilities from the annual survey conducted by Fortune magazine. Fortune magazine publishes annual rankings of the most admired companies in every industry. A group of approximately ten top executives and seven directors per company as well as a pool of industry analysts was selected to rank the firms they admired most on nine criteria. This process resulted in a list of firms ranked on each criterion by industry. The ranking list we used was published in 2009 based on data collected in 2008 from a total of 689 firms in 28 countries. Using this ranking, we identified each firm's relative cross-functional capabilities in its industry.

Using data from the InformationWeek and Fortune surveys has several advantages. First, these surveys provide rankings of firms based on the constructs that are not available from other secondary sources. Second, these surveys conducted by these well-known institutions have higher response rates than most academic studies. For example, the response rate for the InformationWeek survey is around 60% of all companies surveyed (Bharadwaj, 2000). Third,

the respondents for these surveys consist of industry analysts and executives who have abundant experience in the industry and have sufficient knowledgeable to compare firms.

To merge these two data sources, we matched firms ranked in the Fortune most admired company survey with firms recognized as the most innovative users of information technology from the InformationWeek survey. Firms in the Fortune ranking came from 28 countries, had at least $2 billion in revenue, and ranked among the 10 largest in their respective industry; firms in the InformationWeek ranking were U.S firms with at least $500 million in annual revenue. Because of this difference in population, we used the following procedure to combine the two data sources. First, since all the firms in the InformationWeek survey were U.S. based, foreign firms in the Fortune ranking list were removed from our sample pool. This matching process resulted in a final sample of 394 U.S. firms, all having at least $2 billion in revenue and ranking among the 10 largest in their respective industry. All firms in this list have a ranking on each cross-functional capability in their own industry. Second, we matched this list with the InformationWeek list to identify the firms with superior IT capability. Among our sample of 394 firms, 140 firms were recognized as the firms with superior IT capability based on their inclusion in the InformationWeek survey.

Dependent Variable – Tobin's q

We use Tobin's q as the measure of the dependent variable, intangible value. In contrast to intangible value, the tangible value of a firm refers to the value of assets that have a physical substance and can be touched, such as currencies, bonds, buildings, inventory, and equipment. The intangible value of a firm refers to the value of assets that lack physical substance, are untouchable, and have long term profitability. Unlike the tangible value or assets of a firm, which is essentially the book value of a firm, the intangible value of a firm is hard to evaluate. Tobin's q (1969), a forward-looking, stock market-based measure, was developed to estimate the intangible value of firms. It has been used extensively as a measure of a firm's intangible value (Bharadwaj et al. 1999; Raghunathan 1999). A firm's q value is the ratio of its market value to the current replacement costs of its assets (Tobin 1969). Using Tobin's q to measure intangible value is based on the assumption that in the long run the equilibrium market value of a firm must be equal to the replacement value of its assets. In this sense, a firm with a value of Tobin's q higher than one means that the firm has long term profitable assets that are not book-recorded and cannot be reflected from its tangible assets. The higher the value of Tobin's q is, the higher the intangible value of the firm.

We use the Chung and Pruitt's (1998) method to calculate Tobin's q. Several methods have been proposed to calculate the Tobin's q ratio. Among these, the Lindenberg and Ross's (1981) method has been though as the more theoretically correct method. However, the Lindenberg and Ross' algorithm is too complex and cumbersome to be calculated based on the information available from the Compustat database. As a simple approximation of the traditional Tobin's q, the Chung and Pruitt's method requires only basic financial and accounting information all of which are retrievable from the Compustat database. In addition, Chung and Pruitt's methods has been found to be highly correlated with Lindenberg and Ross' theoretically correct formula of Tobin's q. Specifically, after analyzing more than 1,200 firms for 10 years, Chung and Pruitt have found that their method can explain 96.6% to 99.3% of the variability of the Lindenberg and Ross' method. Chung and Pruitt calculate Tobin's q using the following formula:

Tobin's q = (MVE + PS + DEBT)/TA, where:

MVE is the product of a firm's number of common stock shares outstanding and the closing price of share at the end of the fiscal year,

PS is the liquidating value of the firm's outstanding preferred stock,

DEBT is the value of the firm's current liabilities net of its current assets, plus the book value of the firm's long-term debt, and

TA is the book value of the firm's total assets.

Independent Variables

IT capability

The rankings provided by InformationWeek's annual special issue were used to identified a firm's IT capability. Data from the same source has been used as the measure for IT capability in previous studies (e.g., Bharadwaj, 2000). A 7-point ordinal scale is used to measure a firm's IT capability. A firm's IT capability is coded as 7 if the firm is ranked from 1 to 50, 6 if the firm is ranked from 51 to 100, 5 if the firm is ranked from 101 to 150, 4 if the firm is ranked from 151 to 200, 3 if the firm is ranked from 201 to 250, 2 if the firm is ranked from 251-500, and 1 if the firm is not in the ranking list.

Cross-functional capabilities

A firm's cross-functional capabilities were measured by the firm's ranking in the Fortune list. For each industry, Fortune ranked the main firms and provided nine ranking lists of these firms based on nine criteria. Of the nine ranking lists (or, in other words, nine criteria), only four were appropriate to our research question and used to measure the cross-functional capabilities variable. These four ranking lists are rankings of innovativeness, quality of management, quality of products or services, and effectiveness in doing business globally.

Since the raw score is not available from Fortune, we operationalized a firm's cross-functional capabilities based on its ranking. For sensible interpretation, a firm's rankings were reversed using the following formula: ranking score = (n+1-r), where n is the number of firms in the ranking and r is the ranking of the firm. As a result, the ranking score represents a firm's relative capability in its industry: the higher the ranking score, the higher the firm's capability. Then, to compare a firm's relative capability across industry, the ranking score is standardized for data analysis.

Managerial capability refers to a firm's ability to build, integrate, and reconfigure organizational resources and competencies (Adner et al. 2003). This variable was measured by assessing the firm's relative ranking of quality of management in its industry with the following question: "How would you rate these companies on the following attribute: quality of management?"

Global competitive capability refers to a firm's ability to strive in global environments. This variable was measured by the extent to which a firm is effective in doing business globally with the following question: "How would you rate these companies on the following attribute: effectiveness in doing business globally?"

Innovative capability refers to a firm's ability to identify and use opportunities to create new products or services (Subramaniam et al. 2005; Van de Ven 1986). This variable was measured by assessing the firm's relative ranking of innovativeness in its industry with the following question: "How would you rate these companies on the following attribute: innovativeness?"

Product/service quality capability is defined as the ability of a firm to develop and deliver a product/service to satisfy the preconceived wants of the users (Thatcher et al. 2001). We used a firm's relative standing of its quality of products or services in its industry as the indicator for its product/service quality capability. The question asked in the Fortune survey was: "How would you rate these companies on the following attribute: quality of products or services?"

Control variables

Three industry-level and three firm-level control variables that have been suggested by previous studies as having an influence on a firm's Tobin's q were included in the model (e.g., Capon et al. 1990; Szymanski et al. 1993). The three industry-level control variables are industry concentration, industry capital intensity, and industry average q. We use the Herfindahl index, the sum of squares of each firm's market share in an industry, as the measure of industry concentration. An industry's capital intensity was the weighted average of firms' q ratios capital intensity in the industry. An industry's average q was calculated as the weighted average of firms' q ratios in the industry.

The three firm-level control variables included in the study are market share, firm size, and growth rate. Our measure of market share is the ratio of a firm's sales to total sales of all firms in the same industry. We calculated

firm size as the natural logarithm of the total assets of the firm. Finally, the growth in sales served as the proxy for growth rate.

Preliminary Analysis and Results

Next, we present our preliminary analysis of our research-in-progress. (For brevity, the descriptive statistics and correlation matrix are omitted but are available from the authors.)

To investigate the research model, we conducted ordinary least squares (OLS) regression to test hypotheses 1a, 1b, 1c, and 1d. Model 1 examines the effect of the firm and industrial level control variables on Tobin's q. In Model 2, IT capability was introduced into the regression model to investigate the incremental variance explained by that variable after controlling for the firm and industrial level control variables. Finally, Model 3 examines the incremental variance explained by the four cross-functional capabilities after introducing IT capability and controlling for the firm and industrial level control variables. The results from the OLS regression are presented in Table 1.

Table 1. Result of Hierarchical Regression Analysis[1]

	Model 1		**Model 2**		**Model 3**	
	β	**t-value**	**β**	**t-value**	**β**	**t-value**
Firm-level Controls:						
Size: Assets (log)	0.04	0.72	0.05	0.87	0.00	-0.02
Growth	0.13*	2.68	0.13*	2.69	0.12**	2.53
Market Share	-0.08	-1.38	-0.08	-1.39	-0.10*	-1.74
Industry Controls:						
Industry concentration	0.03	0.50	0.03	0.50	0.01	0.26
Industry capital intensity	-0.04	-0.86	-0.05	-0.93	-0.03	-0.68
Industry Q	0.40***	8.51	0.40***	8.50	0.40***	9.01
IT Capability			**-0.04**	**-0.85**	**-0.06**	**-1.25**
Quality Management Capability					**0.25****	**2.65**
Global Competitive Capability					**-0.06**	**-0.91**
Innovative Capability					**-0.13**	**-1.43**
Product/Service Quality Capability					**0.19***	**1.92**
R^2	0.18		0.18		0.26	
Adj. R^2	0.16		0.16		0.23	
ΔR^2			0.00		0.08[a]	

[1]Standard

***Significant at $p < 0.001$ (one tail test); **Significant at $p < 0.01$ (one tail test); *Significant at $p < 0.05$ (one tail test).

[a]Significant at $p < 0.001$.

The results regarding the control variables are generally consistent with extant literature. In all models, firm size in terms of total assets has no relationship with Tobin's q. As expected, growth in sales is positively associated with higher Tobin's q across the three models ($\beta = 0.12$ to 0.13, $p < 0.05$ to 0.001, one tail test). In model 3, market share is associated with Tobin's q, interestingly, in a negative direction ($\beta = -0.10$, $p < 0.05$, one tail test). In all three models, industry average q is positively associated with higher firm Tobin's q ($\beta = 0.40$, $p < 0.001$, one tail test).

In both model 2 and 3, IT capability has no significant relationship with Tobin's q. The incremental variance explained by IT capability is trivial. Specifically, after introducing IT capability into the equation, Model 2 only explained a nonsignificant 0.2% more variance in Tobin's q than does Model 1.

Model 3 tests the relationships between the four cross-functional capabilities and Tobin's q. Managerial capability and product/service quality capability are associated with Tobin's q, but innovative capability and global competitiveness capability are not. After including the four cross-functional capabilities, Model 3 significantly explains 8% more variance in Tobin's q than does Model 2 ($p < 0.001$). Specifically, the standardized coefficient of managerial capability is strongly significant and positive ($\beta = 0.25$, $p < 0.01$, one tail test), providing support for hypothesis 1a. In addition, product/service quality capability is positively associated with Tobin's q ($\beta = 0.19$, $p < 0.05$, one tail test), providing support for hypothesis 1d. The standardized coefficient for both innovative capability and global competitive capability are nonsignificant. Thus, hypothesis 1b and 1c are not supported.

Hypotheses H2a, H2b, H2c, and H2d were examined using four OLS regression models, using cross-functional capabilities as dependent variables and IT capability as an independent variable. The strong positive effect of IT capability on managerial capability supports H2a ($\beta = 0.12$, $p < 0.01$, one tail test). The positive impact of IT capability on global competitive capability supports H2b ($\beta = 0.09$, $p < 0.05$, one tail test). Results for the relationship between IT capability and innovative capability support H2c ($\beta = 0.15$, $p < 0.01$, one tail test). Finally, the positive and significant effect of IT capability on product/service quality capability supports H2d ($\beta = 0.11$, $p < 0.05$, one tail test). In sum, the results have expected signs and are significant, supporting our hypotheses that IT capability positively influences a firm's cross-functional capabilities.

Limitations

This research-in-progress has three key limitations. First, although Tobin's q has been widely accepted as a measure of intangible value, it poses some limitations due to the market-based measure it uses. Specifically, the stock price in the formula reflects the capital market rather than the firm itself (Shepherd 1986). Second, there are certain limitations due to the ranking data used for analysis. The InformationWeek and Fortune rankings reflect experts' opinions, rather than objective evaluations of a firm's capability. Third, we treated firms that do not appear on the InformationWeek survey as having inferior IT capabilities; however their lack of inclusion on the InformationWeek survey may simply be due to not responding to the survey.

Discussion

This research-in-progress draws on the resource-based view of a firm and the hierarchy of capabilities framework to argue the effect of IT capability on cross-functional capabilities and intangible value of a firm. This research-in-progress contributes to the growing body of literature linking IT and firm performance by providing a framework that posits how IT capability may contribute to a firm's intangible value, as well as the intervening mechanisms. In addition, this is one of the few studies to empirically investigate the effect of IT capability based on the capability hierarchy framework.

Contributions to theory

This research-in-progress contributes to the IS literature by extending Grant's hierarchy of capabilities and examining how IT capabilities impact intangible performance because of cross-functional capabilities. Our key contribution is the development and empirical test of the cross-functional capabilities construct and its impact on the intangible value of the firm. Our research model suggests that IT capabilities do not necessarily directly impact a firm's intangible value. It is only when particular cross-functional capabilities are formed can IT capabilities help a firm realize intangible value. Indeed, this contingent perspective on the effect of IT capability on a firm's intangible value complements what has been found in literature. Nevo and Wade (2010) suggested that sustainable competitive advantages are grounded in the synergy resulting from the integration of IT-based resource and organizational resources. They argued the key to forming the synergy is how compatible the IT-based resource is with other organizational resources. Wade and Hulland (2004) also suggested that IT-based resources influence a firm's competitive position indirectly through interactions with other organizational resources. In addition, research has

suggested that the type of IT capability may vary and not all of them contribute to a firm's competitive advantage (Bhatt et al. 2005).

This research-in-progress also contributes to the literature by suggesting that IT capabilities are one of the enablers of cross-functional capabilities. This is consistent with the hierarchy of capabilities posited by Grant (1996), where functional capabilities act as the foundation for cross-functional capabilities. Similarly, IT capabilities, as a firm's functional capability, also act as the source of a firm's dynamic capabilities (Teece et al. 1997). In the framework of dynamic capability, a firm's competitive position is not simply the result of the firm's resources or competences. It is a firm's ability to integrate, form, and reconfigure its resources or competencies that allow the firm to address rapidly changing environments.

Implications for practice

The results of the present study provide some interesting implications for practice. Perhaps most immediately, we would suggest that firms should not just focus on counting immediate financial returns when developing IT capabilities. Rather, more attention should be paid to the intangible value and long term returns of IT capability. Not only do IT capabilities influence a firm's short-term profitability (Bharadwaj 2000; Santhanam et al. 2003), but they may also act as the basic ingredient of a firm's cross-functional capabilities, which in turn impacts a firm's intangible value.

Conclusion

This research-in-progress proposes to investigate how IT capability impacts cross-functional capabilities and the intangible value of a firm. Empirical results from 394 U.S. based companies suggest that cross-functional capabilities do impact a firm's intangible value. Further analysis will investigate the impact of IT capabilities on cross-functional capabilities and the overall effect on intangible value.

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