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IT CAPABILITIES: THEORETICAL PERSPECTIVES AND EMPIRICAL OPERATIONALIZATION

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Abstract

With increased emphasis on the strategic role of IT in contemporary organizations, it is imperative to gain a deeper understanding of the factors that govern a firm's IT capability. Yet, there exists very little understanding as to what constitutes a firm's IT capability and how it could be measured. Drawing from theoretical perspectives and a systematic multi-stage research framework based on Delphi panels and focus groups, we conceptualize an enterprise-wide IT capability as a second order factor model. Using structural equation modeling techniques, the IT capability construct is empirically verified. Our study results provide a useful tool for benchmarking IT capability and serves as a foundation for operationalizing a key dependent variable in IT-business value research.

1. INTRODUCTION

Contemporary thinking on organizational capabilities has been profoundly influenced by the resource-based view (RBV) of the firm (Barney 1991; Eisenhardt and Schoovenhoven 1996; Penrose 1958). In this view, firms possess bundles of costly-to-imitate resources that are regarded as the fundamental drivers of superior performance (Helleloid and Simonin 1994; Reed and DeFillippi 1990). The resource-based view also promotes a distinction between resources and capabilities: capabilities reflect the ability of firms to combine resources in ways that promote superior performance (Amit and Schoemaker 1993). While firm resources are copied relatively easily by competition, capabilities are more difficult to replicate because they are tightly connected to the history, culture, and experience of the firm.

Recent writings in the IS literature have also turned their attention toward the role of IT capabilities in enabling superior IT-based innovation and business performance. These studies have identified broad classes of IT-related resources such as IT infrastructure, human IT skills, and organizational resources related to IT development such as a strong partnering relationship between IT and business unit management (Bharadwaj, Bharadwaj and Konsynski 1999; Mata, Fuerst and Barney 1995; Ross, Beath and Goodhue 1996; Weill and Broadbent 1998). What is missing, however, is an integrative conceptualization of IT capability as a multi-dimensional construct encompassing both the technical and organizational dimensions. Additionally, there has been virtually no empirically based theory related to IT capability as much of the extant literature are based on anecdotal evidence, discussions with a few visionary IS executives, or case studies of highly successful firms.

This paper reports upon the results of a multi-year empirical investigation into the nature and structure of IT capabilities. The project used a variety of methodologies including Delphi panels, focus groups, and large-scale questionnaire surveys in order to elicit a deeper understanding about critical IT capabilities that might be associated with superior business performance. This paper presents our results on the dimensions of IT capabilities and confirmatory evidence about their structure through a rigorous analysis of large-scale questionnaire data.

1.1 IT Capability (ITCAP): The Construct

Our field-based investigation of IT capability began with a Delphi process that included experts on IT management within academia, consulting practice, and industry. The Delphi panelists were asked to describe their views about specific capabilities that are associated with the ability to sustain IT innovation success in contemporary firms. Next, the researchers organized these initial lists into related categories. During the second round, members were asked to (1) add or delete specific capabilities and (2) confirm our organization of the capabilities into related categories or suggest alternative classifications. The Delphi panel resulted in a list of 32 capabilities organized into six categories.

In the second stage, the results of the Delphi process were validated through a series of four focus groups. Our intent was to ensure that the identified capabilities did not simply reflect contemporary thinking about appropriate IT management practice but tapped into a more stable set of ideas that would describe firm-wide IT capabilities. The final result of the four focus group discussions was a set of 30 capabilities organized into six categories: *IT business partnerships, external IT linkages*, *business IT strategic thinking, IT business process integration, IT management,* and *IT infrastructure*. These capabilities are illustrated in Table 1 and described in the following sections.

IT business partnerships. This dimension refers to the firm's ability to foster rich partnerships between the technology providers (IT professionals) and technology users (business unit managers). It includes aspects related to the blending of business and IT experience through multi-disciplinary teams and encouraging risk sharing and experimentation with IT (Henderson 1990). Specifically, relationship building facilitates wider dialogue between the business and IS communities and involves developing user's understanding of IT's potential (Feeny and Willcocks 1998). Without exception, the CIOs in our expert panel agreed that rich interaction between the IT staff and business unit managers was critical for developing innovative IT applications

External IT linkages. This dimension refers to technology based linkages between the firm and its key business partners, including customers, suppliers, and other external collaborators. Interorganizational ITs such as EDI networks and other electronic distribution channels facilitate sophisticated interactions with suppliers and customers and foster sharing of knowledge and customer information. (Konsynski and McFarlan 1990; Zaheer and Venkatraman 1994). Discussions regarding IT capabilities with the focus group participants reaffirmed the idea that IT capabilities pertain not just to the technology opportunities within the firm but with external partners as well. For example, one of the firms in the focus group had invested considerable resources in educating its customers regarding the advantages of interorganizational linkages as a means of encouraging collaborative relationships.

Business IT strategic thinking. This dimension refers to the management's ability to envision how IT contributes to business value and the ability to integrate IT planning with the firm's business strategies. In the IS literature, the importance of integrating IT and business strategy has been abundantly emphasized on the grounds that IT affects firm strategies and that strategies have IT implications (Bakos and Treacy 1986; Beath and Ives 1986; Feeny and Wilcocks 1998; Henderson and Venkatraman 1993; Quinn and Baily 1994). McKenney (1995) point out how firms that had pioneered framebreaking innovations with IT had developed clear visions about the role of IT and the connections between IT and their core value propositions. For example, one of the managers in the Delphi panel pointed out that his firm required strategic business plans to address specific IT-related issues and senior business managers were required to articulate IT's role within their business units.

Table 1. Initial Structure of IT Capabilities[a]

IT business partnerships	
IBP1	Multi-disciplinary teams to blend business and technology expertise
IBP2	Relationship between line management and IT service providers
IBP3	Line management sponsorship of IT initiatives
IBP4	Climate that encouraging risk taking and experimentation with IT
IBP5	Climate nurturing IT project championship
IBP6	IT-related educational initiatives for management
External IT linkages	
EIT1	Technology-based links with customers
EIT2	Technology-based links with suppliers
EIT3	We use IT-based entrepreneurial collaborations with external partners
EIT4	Leveraging of external IT resources (IT vendors and IT service providers)
Business IT strategic thinking	
BIT1	Clarity of vision regarding how IT contributes to business value
BIT2	Integration of business strategic planning and IT planning
BIT3	Management's ability to understand value of IT investments
BIT4	Funding for scanning and pilot-testing "next generation" IT
BIT5	Technology transfer mechanisms
IT business process integration	
BPI1	Consistency of IT application portfolios with business processes
BPI2	Restructuring of Business work processes to leverage opportunities
BPI3	Restructuring of IT work processes to leverage opportunities
IT management	
ITM1	Effectiveness of IT Planning
ITM2	IT project management Practices
ITM3	Planning for security control, standards compliance, and disaster recovery
ITM4	Systems Development Practices
ITM5	Consistency of IT Policies throughout the enterprise
ITM6	IT evaluation and Control Systems
ITM7	Adequacy of the skill base
IT infrastructure	
INF1	Appropriateness of the data architectures
INF2	Appropriateness of network architectures
INF3	Adequacy of architectural flexibility
INF4	Efficiency and reliability of IT operations
INF5	Processing capacities

[a]Items IBP6, EIT4, BIT4, and BIT5 were eventually dropped from the respective dimensions.

IT business process integration. Business process integration refers to the ability to adapt existing business and IT work processes to continually enhance their effectiveness and efficiency as well as to leverage the capabilities of emerging information technologies (Davenport 1993). It requires the restructuring of existing business practices as well as restructuring of existing IT work processes to ensure that new opportunities for process efficiency are exploited. The IS managers in our panel clearly saw this as an essential component of a firm's IT capability and indicated that an effective mechanism for achieving business process integration is through formally constituting BPR groups as a permanent workgroup.

IT management. The IT management dimension taps into activities related to the management of the IT function, such as IS planning and design, IS applications delivery, IT project management, and planning for IT standards and controls (DeLone 1988; Magal, Carr, and Watson 1988; Martin 1982; Zahedi 1987). Boynton, Zmud, and Jacobs (1993) found that the quality of IT management practice had a significant impact on firms' overall IT success. Effective IT management ensures consistency of IT policies throughout the enterprise and reduces duplication and redundancies in systems.

IT infrastructure. IT infrastructure refers to the foundation for enterprise applications and services and is comprised of data, network, and processing architectures (Duncan 1995; Weill and Broadbent 1998). An IT infrastructure influences the reach and range of business opportunities available to firms in applying IT to shape global business strategies (Keen 1991). Our expert panel of IS managers also pointed out the need for ensuring the efficiency and reliability of IT operations and ensuring that adequate processing capacities existed. They indicated that control strategies to ensure operational efficiency of data centers and network operations might include the systematic comparison of system performance measures against industry/vendor benchmarks.

1.2 Conceptual Model of IT Capability

From the preceding discussion, it appears that an enterprise-wide IT capability is manifest in several distinct although related facets. These facets encompass both organizational and technological capabilities and, considered together, reflect a firm's overall ability to sustain IT innovation and respond to changing market conditions through focused IT applications. We therefore conceptualize IT capability (ITCAP) as a higher-order (second order) construct reflected by a firm's abilities in the underlying first-order facets of IT business partnerships (IBP), external IT linkages (EIT), business IT strategic thinking (BIT), IT business process integration (BPI), IT management (ITM), and IT infrastructure (INF).

2. EMPIRICAL ASSESSMENT OF THE ITCAP CONSTRUCT

2.1 Sample and Procedure

Data were gathered through a large sample field survey that tapped responses from senior IS executives. The sampling frame was developed by cross-listing firms from *Fortune 500*, *Service Fortune 500*, and *Business Week 1000* with the *IS Executive* database. The latter database was used to determine the names of the senior-most IT executives in those firms. This strategy resulted in a sampling frame of 1,120 medium to large U.S. firms from eight industries, including manufacturing, transportation, utilities, retail, banking and financial services, petroleum, food, and insurance. Respondents were presented with the list of 30 items (see Table 1) and were asked to rate their firm's performance on each item, *relative to other firms in their industry*, using a five-point Likert scale ranging from "exceptionally well" to "poorer than most."

2.2 Model Properties

We evaluated the psychometric properties of the first and second order constructs through a series of confirmatory factor analyses on the covariance matrices using LISREL version 8. The expectation is that the item measures in Table 1 will uniquely measure their associated facets and the set of facets taken together will measure the overarching latent (second-order) construct of ITCAP.

Unidimensionality and convergent validity. Unidimensionality refers to the existence of one latent trait or construct underlying a set of indicators (Gerbing and Anderson 1988). As noted earlier, our *a priori* specification comprised 30 items hypothesized to load on six (first-order) constructs. Two items each from IT infrastructure (INF4 and INF5) and business IT strategic thinking (BIT4 and BIT5) and one item each from IT business partnership (IBP6), external IT linkages (EIT4), and IT management (ITM7) were dropped due to significant cross loading with other constructs. The measurement properties of the observed variables (23 items), including the item means, standard deviations, standardized parameter estimates, and *t*-values at the factor level are presented in the top panel of Table 2. All items have significant loadings on their corresponding factors, indicating evidence of good convergent validity (average loading = 0.64 and average *t*-value = 8.9). The bottom panel of Table 2 shows the measurement properties for all of the latent constructs included in the second-order construct of ITCAP. All structural coefficients are of high magnitude and exhibit significantly high *t*-values.

Table 2. Final Measurement Properties of IT Capability Measures

Item	μ	σ	λ	t	std error
IT business partnerships (IBP)					
IBP1	2.610	0.996	0.70	10.50	0.07
IBP2	2.445	0.787	0.64	9.41	0.05
IBP3	2.660	0.910	0.72	10.90	0.06
IBP4	3.005	0.905	0.57	8.08	0.06
IBP5	2.615	0.889	0.70	10.48	0.06
External IT linkages (EIT)					
EIT1	2.675	0.961	0.67	8.19	0.08
EIT2	3.050	0.890	0.60	7.07	0.08
EIT3	3.135	0.878	0.64	8.57	0.07
Business IT strategic thinking (BIT)					
BIT1	2.825	0.905	0.81	11.27	0.07
BIT2	2.655	0.954	0.68	8.76	0.07
BIT3	2.705	0.775	0.63	9.05	0.05
IT business process integration (BPI)					
BPI1	2.500	0.814	0.73	10.67	0.06
BPI2	2.855	0.926	0.56	7.88	0.07
BPI3	2.770	0.788	0.62	9.07	0.05
IT management (ITM)					
ITM1	2.690	0.882	0.69	10.13	0.06
ITM2	2.740	0.791	0.63	9.05	0.06
ITM3	2.460	0.890	0.49	6.67	0.07
ITM4	2.820	0.755	0.54	7.48	0.05
ITM5	2.975	0.859	0.59	8.30	0.06
ITM6	2.990	0.723	0.59	8.37	0.05
IT infrastructure (INF)					
INF1	2.760	0.828	0.67	8.87	0.06
INF2	2.455	0.794	0.52	6.74	0.06
INF3	2.665	0.804	0.67	9.13	0.06

χ^2 (208) = 294.44; CFI = 0.94; TLI = 0.93; RMSEA = 0.046; RMR = 0.038; GFI = 0.89; AGFI= 0.85

II-ORDER MODEL

CONSTRUCT	λ	**t**	Std. error
IBP	0.88	5.46	0.16
EIT	0.68	5.71	0.12
BIT	0.82	5.40	0.15
BPI	0.92	3.18	0.29
ITM	0.81	6.14	0.13
INF	0.71	5.94	0.12

χ^2 (217) = 314.77; CFI = 0.93; TLI = 0.92; RMSEA = 0.049; RMR = 0.041; GFI = 0.88; AGFI = 0.85

Other model fit parameters for the second-order model also indicate adequate model fit. The overall χ^2 for the second-order model at 314.8 (df = 217; p = 0.0) was significant, as might be expected with the statistic's sensitivity to sample size (Bagozzi, Yi and Phillips 1991). However, the normed χ^2, which is a more commonly used metric in evaluating models with large degrees of freedom is 1.45, implying good model fit and no evidence of over-fitting (Joreskog 1993). Additionally, the Comparative Fit Index (CFI) (Bentler 1990) for the model at 0.93 and the Tucker-Lewis Index (TLI) at 0.92 (Tucker and Lewis 1973) are greater than the recommended level of 0.9. Finally, the goodness-of-fit index (GFI = 0.88), the adjusted goodness-of-fit index (AGFI = 0.85) and root mean square error of approximation (RMSEA = 0.04) are all within acceptable ranges, indicating that the model accounts for a substantial amount of the variance (Bagozzi, Yi, and Phillips 1991).

Assessment of reliability. Beyond examination of the loadings for each indicator, a principal measure used in assessing the measurement model is the composite reliability of every latent construct in the model. Reliability scores provide an indication of the degree to which measures are free from random error and yield consistent results. As shown in Table 3, the reliability scores for the six (first-order) constructs ranged from 0.67 to 0.8, providing a direct assessment of construct reliabilities. The overall composite reliability score for the second-order construct ITCAP is 0.92, indicating good overall reliability of the model.[1]

Assessment of discriminant validity. Discriminant validity refers to the extent to which measures of the different model dimensions are unique and is generally assessed by testing if the correlation between pairs of dimensions are significantly different from unity (Anderson 1987; Venkatraman 1989). This is carried out through pairwise χ^2 difference tests requiring the estimation of 30 covariance structures (15 constrained and 15 unconstrained) and evaluation of 15 χ^2 differences. In order to establish discriminant validity, the χ^2 value of the unconstrained model must be significantly lower than that of the constrained model. As shown in Table 4, in all cases the χ^2 difference was significant at the 0.01 level, indicating that the fit of the unconstrained model is significantly better than the constrained model, and thereby providing strong support for discriminant validity.

3. CONCLUSION

With increased emphasis on the strategic role of IT in contemporary organizations, it is imperative to gain a deeper understanding of the factors that govern a firm's IT capability. As Henderson and Venkatraman point out, IT capability is not so much a specific set of sophisticated technological functionality as it is an enterprise-wide capability to leverage technology to differentiate from competition. Strategic advantage results to organizations that can exploit IT functionality on a continuous basis. To be able to do so, however, requires a clear understanding of the critical components of IT capability and their role in supporting and shaping business strategy.

This study represents a step toward a better understanding of the IT capability construct and its dimensions. It provides a conceptual and empirical basis for understanding IT capability as an enterprise-wide dynamic capability reflected by strong capabilities in six distinct but related constructs. Our conceptualization of the IT capability construct emerged from the IS literature and a systematic multi-stage iterative research method based on Delphi studies and focus groups with IT experts. The six (first order) constructs explicated in this study provide a useful conceptualization of IT capability for both IS researchers and practitioners.

Table 3. Construct Reliability

CONSTRUCT	Number of indicators	RELIABILITY
ITCAP (II Order Construct)	6 facets	0.92
IBP (I order)	5	0.80
EIT (I order)	3	0.67
BTI (I order)	3	0.75
BPI (I order)	3	0.68
ITM (I order)	6	0.76
INF (I order)	3	0.65

[1]Generally, the reliability of second-order factors is not computed. We adapted a procedure described in Kumar, Scheer and Steenkamp (1995). Approximate loadings of the items on the second-order construct were computed by multiplying the standardized first-order loadings with the standardized second-order loadings. The approximate loadings for the 23 IT capability items computed in this way were used to estimate the composite reliability.

Table 4. Results of Discriminant Validity Tests

Test	Constrained Model		Unconstrained Model		
	χ	degree of freedom	χ^2	degree of freedom	Change in χ^2
IT business partnerships					
External IT linkages	73.37	20	32.30	19	41.07
Business IT thinking	72.62	20	43.59	19	29.03
IT business process integration	46.62	20	36.82	19	9.80
IT management	136.97	44	73.26	43	63.71
IT infrastructure	100.89	20	44.31	19	56.58
External IT linkages					
Business IT thinking	33.32	9	10.34	8	22.98
IT business process integration	42.07	9	18.00	8	24.07
IT management	63.13	27	40.07	26	23.06
IT infrastructure	63.88	9	17.15	8	46.73
Business IT thinking					
IT business process integration	36.23	9	28.21	8	8.02
IT management	78.10	27	42.35	26	35.75
IT infrastructure	53.65	9	9.65	8	44.00
IT business process integration					
IT management	68.02	27	26.95	26	41.07
IT infrastructure	49.29	9	34.80	8	14.49
IT management					
IT infrastructure	63.92	27	27.60	26	36.32

While a substantial body of IS literature has focused on identifying the competitive advantages resulting from specific IT applications, we feel that it is more important for firms to move away from focusing too narrowly on singular applications whose competitive advantage is at best short-lived, but instead focus on creating a firm-wide IT capability that provides a substantive basis for sustained IT innovation. This perspective ties in to the resource-based view of the firm with emphasis on identifying and creating underlying core capabilities that enable continuous innovation and adaptation to changing environmental conditions.

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