The Development and Application of a Value-based Thermometer of IT Business Value

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ABSTRACT

The issue of whether organizations are receiving adequate returns from their investments in information technology (IT) remains an important managerial concern. Although productivity impacts are an important dimension of IT business value, there is a growing acceptance of the need to expand the concept of IT business value to include a broader range of IT impacts than productivity impacts alone. This paper attempts to address this need by developing a multidimensional "thermometer" of IT business value.

The construction of our business value thermometer centers on the value-chain — a generic configuration of business processes and inter-process linkages where senior management allocate IT and related resources in an attempt to improve organization performance. If IT investment proves effective and payoffs from IT are realized, this will be reflected in managerial perceptions of IT impacts. Consequently, focusing on managerial perceptions of realized process-level impacts from IT investment throughout the value chain can provide a basis for an overall firm-wide measure of IT business value.

We use perceptual data collected from business executives to provide a formal test of the value chain model. Our findings confirm that the impact of IT on business processes within the value chain is an effective structure through which to measure IT business value. Furthermore, we reveal how process-level impacts can be calibrated and converted into an organizational thermometer of IT business value.

1. Introduction

The debate surrounding payoffs from corporate investment in information technology (IT) continues to rage. Proponents of the "productivity paradox" continue to cite a lack of substantive evidence to support the claim that corporate IT investment enhances productivity at the firm-level (Strassmann 1997). At a time when US corporations are increasing their investments in IT — with several already spending in excess of $1 billion annually (Information Week 1996) — the notion that these investments might fail to make an appreciable impact on firm performance is cause for concern.

Although the performance implications of IT investment embrace multiple impacts, information systems (IS) researchers have tended to focus on productivity impacts at the firm-level. Unfortunately, the overall findings from this branch of research have been contradictory, fueling the debate on the existence of a productivity paradox. For example, based on a study of the productivity impacts of IT in manufacturing, Loveman (1994) argued that "the marginal dollar would best have been spent on non-IT inputs into production, such as non-IT capital" (p. 85). Findings from other studies have ranged from identifying negative relationships between IT investment and various organizational performance criteria (Weill 1992; Berndt and Morrison 1995), to neutral or bi-modal impacts (Cron and Sobol 1983; Strassmann 1990; Harris and Katz 1991; Weill 1992), to suggesting positive and significant returns from IT (Lichtenberg 1993; Barua, Kriebel and Mukhopadhdyay 1995; Brynjolfsson and Hitt 1996b; Hitt and Brynjolfsson 1996).

Clearly many questions remain unanswered. While productivity impacts may be an important element of IT business value — defined as the contribution of IT to firm performance (Berger, Kobielus and Sutherland 1988) — many researchers now argue that it is necessary to adopt a more comprehensive interpretation of IT business value (Strassmann 1990; Kaplan and Norton 1992; Brynjolfsson 1993).

In recognition of this broader interpretation, this paper presents a multidimensional model of IT business value. The specific purpose of this model is to serve as an organizational thermometer of IT business value. The properties of the proposed business value thermometer mirror those of a physical thermometer. For example, the level of the business value thermometer should reflect changes in IT impacts over time. The thermometer should be calibrated so that the level of business value can be easily determined at any point in time. Finally, there should be some notion of what constitutes a "normal" level of IT business value. Just as 98.6° describes normal body temperature, for benchmarking purposes, the business value thermometer must be able to distinguish firms that exceed a "normal" level of IT business value from those that do not.

1.1 Value Creation

We argue that the construction of a thermometer of IT business value should reflect a clear understanding of why organizations invest in IT. If organizations' investment decisions are goal-oriented, as the organizational literature suggests (Cyert and March 1963; Etzioni 1964; Thompson 1967; Scott 1992), then value creation can be regarded as a focal organizational goal.

The concept of value creation combines both traditional objective outcomes, such as profitability or revenue growth, with more subjective outcomes, such as quality, customer satisfaction or managerial effectiveness. Excluding subjective outcomes from an assessment of IT business value, as has been the case with many studies of firm performance, is tantamount to valuing those outcomes at zero. Therefore, measuring IT business value using objective outcomes alone, runs the risk of understating the impacts of IT investment due to the non-quantifiable nature of certain subjective outcomes. Therefore, in an effort to include both quantifiable and non-quantifiable impacts in our business value thermometer, this study uses perceptual measures of IT business value.

The remainder of this paper is organized as follows: the next section provides the theoretical background for our model. Section 3 outlines the research model, while in section 4 we describe the data and methodology used to test the model. Section 5 presents detailed findings which are then discussed in section 6. Finally, we conclude on the appropriateness of the model as a structure for measuring IT business value.

2. Theoretical Background

One approach to measuring IT business value is to focus on areas within the organization where value is created. Crowston and Treacy (1986) suggest that the specific value of IT is determined by the strategic objectives or business goals for which the technology is deployed. Correspondingly, the motivation for deploying IT suggests the best method for evaluating performance impacts. Berger (1988) supports this view, arguing that the criteria for measuring an information system’s impact should vary with the rationale for its application. Similarly, Kauffman and Kriebel (1988) suggest that a way of coping with the diversity of potential impacts from IT is through a classification of IT applications that facilitates selection of appropriate measures by type, such as administrative cost reduction, productivity improvement, customer service enhancement, or new product strategies. Collectively, this research suggests that IT business value measures ought to take account of the multidimensional nature of IT impacts. For this reason, our thermometer of IT business value is designed to incorporate a broad range of IT impacts, resulting in a complementary, yet more comprehensive, assessment of IT business value than that afforded by objective measures alone.

2.1 A Process-oriented Approach to IT Business Value

Various researchers have argued for adopting a process-oriented view of IT business value since IT impacts are realized at the process-level (Crowston and Treacy 1986; Bakos 1987; Kauffman and Weill 1989; Wilson 1993). However, where process-oriented studies have appeared (Banker and

Kauffman 1988, 1991; Banker, Kauffman and Morey 1990), their application has centered on specific technologies thus limiting the generalizability of their findings to other technologies and organizational contexts. This observation led Mooney, Gurbaxani and Kraemer (1995) to develop a process-oriented framework of IT business value based on the notion that organizations derive business value through the impact of IT on intermediate business processes. This framework centers around operational processes that comprise a firm's value chain and management processes involving information processing, control, coordination and communication. This paper builds upon that framework by developing a process-oriented model of IT business value.

2.2 Perceptual Measures of Firm Performance

Whereas there are established measures of firm performance founded on economic perspectives, there is a noticeable paucity of business value measures derived from organizational and behavioral perspectives. Nevertheless, perceptual measures of firm performance[1] have appeared (Venkatraman 1989; Chan and Huff 1993; Raymond, Paré and Bergeron 1993; Bergeron and Raymond 1995). Despite a concern among some researchers that perceptual data may be subject to exaggeration by the respondent, perceptual measures of firm performance have been shown to correlate highly with objective measures (Dess and Robinson 1984; Venkatraman and Ramanujam 1987). Specifically, in a study comparing objective with perceptual measures of firm performance, Venkatraman and Ramanujam (1987) conclude that "perceptual data from senior managers... can be employed as acceptable operationalizations of [business economic performance]" (p. 118).

Research on executives' perceptions of IT has appeared in a number of studies. For example, IS researchers have used subjective measures to assess the "success" of IS projects and the IS organization

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[1] For example, executives have been asked to rate their firm's performance relative to that of their competitors using a set of key performance variables, such as cash flow, profitability, and profit margins.

(Lucas 1975; DeLone and McLean 1992). However, both sets of measures are intermediate in the sense that they are expected to contribute to IT business value; they are not definitive measures of IT business value in any sense. Broadbent and Weill (1993) posit a relationship between managerial perceptions of the role of IT infrastructure, the perceived value of that infrastructure, and their IT investment biases. Research has also determined that a CEO’s perceptions and attitudes towards IT and the degree of importance attributed to IT by the CEO, TD ti C

Millar 1985). These activities are subdivided into primary activities and support activities. Although discrete, these processes remain interdependent.

How technology is used in individual processes will be an important determinant of IT business value. Specifically, IT creates value for the organization by improving individual business processes, or inter-process linkages, or both. For example, when a firm's production schedule is linked to real time sales data, this linkage may not only create efficiencies in production but customer relations might also be improved through increased responsiveness. In general, the greater the impact of IT on individual business processes and on inter-process linkages, the greater will be the contribution of IT to firm performance. Since the primary emphasis of the value chain is on value creation, we believe the value chain provides an ideal structure for measuring IT business value at the process-level. Moreover, a process-oriented perspective should provide greater insights into how value is created, while offering an explanation of the technological features, process characteristics and managerial practices conducive to IT business value creation.

3.1 Outline of the Model

We began by reviewing the academic and professional literature in order to classify process-level impacts under distinct dimensions of IT business value. Based on our argument that IT investment is undertaken in pursuance of organizational goals, we concentrated on identifying dimensions of business value where senior management might concentrate IT resources as a means of creating or adding value. Our review identified seven distinct dimensions of business value (Table 1). As these dimensions span the value chain, combining these multiple dimensions into a single model effectively creates a firm -wide IT business value construct.

Insert Table 1 about here

These seven dimensions were then used to construct a value chain model of IT business value (Figure 2). Support activities from Figure 1 were operationalized as *Process Planning and Support*, while the processes denoting an organization's primary activities are shown as *Supplier Relations*, *Production & Operations*, *Product & Service Enhancement*, *Sales & Marketing Support* and *Customer Relations*. The horizontal links between the primary activities represent the value accumulation concept of the value chain. Since competitiveness, as one possible consequence of the value chain, is closely aligned with the Competitive Forces Model (Porter 1985 - bargaining power of buyers and suppliers, threats from new entrants and substitutes), we linked the *Competitive Dynamics* variable with the primary activity variables from the value chain.

Insert Figure 2 about here

As structural equation modeling (SEM) was used to test our model, the layout of the model follows generally accepted SEM notation. Since IT business value cannot be directly measured or observed, it is depicted as a latent variable. The observed impact of IT on each primary business process is shown as a reflective indicator, while the impact of IT on *Process Planning and Support* is shown as a formative indicator. The links between processes in the value chain are represented by directed lines.

In order to understand why the primary variables are modeled as reflective indicators, we need to distinguish between the causes and effects of business value. Although not discussed here, the “causal” variables in our conceptualization of IT business value are based on the concept of strategic alignment (Chan and Huff 1993, Henderson and Venkatraman 1993; Reich and Benbasat 1996). One element of strategic alignment which is included in this study is *Process Planning and Support*. We hypothesize that the effects of strategic alignment will materialize as impacts of IT on business processes. This line of reasoning is analogous to a doctor using a patient’s vital signs to assess their general state of health. Rather than saying that vital signs “cause” health (implying formative indicators), we consider them as symptoms or consequences of an individual’s health (suggesting reflective indicators). In point of fact, the things that “cause” health are living habits, regular exercise, and diet. Therefore, just as a doctor might use a patient’s vital signs to make certain inferences about that individual’s health, we use process-level IT impacts to measure IT business value.

4. Data Collection and Methodology

The data for this study came from a survey of business executives. Survey packets were mailed to the CIOs of 350 Fortune 500 companies during 1995. Each CIO was asked to forward a copy of the survey to key business executives within their organization. In soliciting multiple responses from each organization, we sought to avoid problems associated with key respondent bias. Individual respondents were asked to reply directly to the authors.

The survey contained 45 items (Appendix I). Each item was carefully chosen based on the supporting literature (Table 1). Respondents were asked to rate the extent to which they believed IT contributed to overall firm performance across a broad range of process-level impacts. Respondents were asked to restrict their responses to realized IT impacts, rather than expected impacts. Individual survey items were rated using a 10-point Likert scale where 1 indicated “no realized impact” and 10 indicated “high realized impact”.

Responses were received from 180 senior executives across 42 corporations. To check for response bias, we compared the 42 corporations in our sample with the Fortune 500 for a set of key financial variables reported by Compustat. The results of this analysis suggest that our sample is free from bias and, therefore, representative of Fortune 500 firms.

4.1 Factor Analysis

We began by using factor analysis to identify the dimensionality of our data. Confirmatory factor analysis (CFA) can be applied in instances where plausible model structures exist and where the number of factors is specified in advance (Bollen 1989). On the basis that our survey instrument was designed to measure specific factors, we opted for confirmatory, rather than exploratory factor analysis (EFA). Allowing for correlated factors, the standardized factor loadings for the CFA (maximum likelihood estimation) are shown in Table 2.

Insert Table 2 about here

Although the fit statistics for the CFA[2] are marginal (χ^2 = 2382.301, df = 924, $p<0.001$; NFI = 0.779; NNFI = 0.840; CFI = 0.851; GFI = 0.627; RMSEA = 0.094), the factor loadings are consistently above a minimum standard of 0.6 advocated by Bagozzi and Yi (1988). This result allows us to accept the hypothesized seven factor structure behind our data.[3]

4.2 Validity and Reliability

Bollen (1989) defines content validity as "a qualitative type of validity where the domain of a concept is made clear and the analyst judges whether the measures fully represent the domain" (p. 185). Content validity is achieved by grounding the meaning of a concept in a theoretical definition that reflects past research efforts at exploring the concept under review. Furthermore, each definition should have at least one measured item. Since the seven dimensions of IT business value used in this study, and the 45 items used in their measurement, were based on an extensive literature review (Table 1), we believe content validity has been adequately supported.

Insert Table 3 about here

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[2] Using the method described in MacCallum, Browne and Sugawara (1996), the power of this CFA test is approximately 1.000

[3] As an aside, we performed an EFA on the 45 items (maximum likelihood extraction). Using the eigenvalue ≥ 1 rule, a seven factor structure emerged, explaining 80% of the total variance. The items loading on each factor were, without exception, the same as those tested in the CFA.

If our measurement instrument is to pass a test of both convergent and discriminant validity, then the shared variance between each two factor pairing should be less than the corresponding variance extracted for each factor in turn. The results of our convergent and discriminant analysis are given in Table 3. Entries along the main diagonal represent variance extracted by the items measuring each dimension.[4] All other entries denote shared variance, found by repeatedly pairing factors and squaring the estimated correlation between them. As an assessment of the variance extracted for each dimension, we followed the recommendation that the mean variance extracted should exceed 0.50 (Fornell and Larcker 1981). Elements along the main diagonal in Table 3 clearly comply with this recommendation. An overall comparison of the shared variances for each dimension pairing with their respective variance extracted confirms that discriminant and convergent validity is present.

Composite reliabilities were calculated using the method described in Werts, Linn and Jöreskog (1974). As composite reliabilities were above 0.9 and factor loadings were consistently high, it was deemed appropriate to collapse the items under each factor into a composite factor score. The score for each factor was based on an average of the items loading on that factor. Creating composite scores, in this manner, reduces the statistical power of the model to more realistic levels and prevents the degrees of freedom in the CFA or measurement model from dominating the degrees of freedom in any subsequent structural model.

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[4] The variance extracted is defined as:

$$\frac{\sum_{i=1}^{p} \lambda_i^2}{\sum_{i=1}^{p} \lambda_i^2 + \sum_{i=1}^{p} (1 - \lambda_i^2)}$$

where λ_i is the standardized factor loading relating variable i to the underlying theoretical factor. p is the number of items loading on each factor (Fornell and Larcker 1981).

4.3 Structural Model Specification

SEM allows us to simultaneously evaluate the hypothesized links shown in Figure 2. To consider the value chain model as a thermometer of IT business value, our analysis must proceed in two stages. In the first stage, SEM attempts to validate a “simple” or uncalibrated value chain model. This will allow us to determine if the value chain is an effective structure through which to measure IT business value. If successful, the second stage will use SEM to apply a calibration scale to the “simple” value chain model, in effect transforming it into a thermometer of IT business value.

In terms of SEM, the “simple” value chain model attempts to reproduce the original covariance matrix while the more complex calibrated model attempts to reproduce both the covariance matrix and the means of the observed variables. In this instance, means refer to the average measured impact of IT on each business process. By including means in our structural model, we effectively map a calibration scale onto the “simple” value chain model. Since the observed variables are based on a 10-point Likert scale (described earlier), our calibration scale inherits this same 10-point scale.

In order to include means in our structural model, we introduce a dummy variable to denote an intercept parameter. The inclusion of this parameter is for modeling purposes only; it is not part of the original model and, therefore, has no specific interpretation outside the model. Since the intercept is designed to reproduce the observed means, it must be “anchored” to each observed variable and the IT business value latent variable. This anchoring process is accomplished using addition links which are inserted into the original “simple” value chain model. To distinguish these additional links from those in the original “simple” value chain, we use dashed instead of solid lines (as shown in Figure 3). Due to the construction of the model, we can trace a link from the intercept to every observed variable in the value chain simply by passing through supplier relations. Therefore, there is no need to include a link to every variable; one link will suffice.

The ratio of 180 respondents to 22 estimated parameters in the “simple” value chain model (25 in the calibrated model) clearly meets the recommendation given by Bentler and Chou (1987) who advocate a sample size to estimated parameter ratio of 5 to 1, under assumptions of normality. The software used to analyze both models was EQS v5.2 (Bentler 1995).

5. Model Estimation and Results

A preliminary analysis of our data yielded evidence of multivariate non-normality (Mardia’s normalized coefficient was 13.6, while a rule of thumb for multivariate normality would suggest a normalized coefficient of 3). For this reason, our models used robust maximum likelihood (ML) estimation. The use of robust estimation gives standard errors that are correct where distributional assumptions surrounding the data are unspecified (Bentler and Dijkstra 1985; Bentler 1995). In addition to corrected standard errors, robust estimation in EQS also reports the Satorra-Bentler scaled test statistic. This test statistic produces a distribution that is better approximated by a χ^2 distribution than a test statistic reported under conditions of non-normality (Satorra and Bentler 1994; Bentler 1995).

One way of avoiding distributional assumptions involves the use of bootstrapping techniques (Efron and Tibshirani 1993). While certain estimation procedures assume underlying distributional properties, for example multivariate normality, an application of the bootstrap requires no such assumptions. The adoption of the bootstrap can be particularly useful considering that ML procedures will underestimate standard errors when the population distribution is skewed (Boonsma 1983; Ichikawa and Konishi 1995). For this reason, bootstrapping was used throughout this study as a way to assess the robustness of the ML estimates reported by our models.

5.1 Evaluating the Model Fit

The concept of “model fit” is based on the notion that a model is said to fit the sample data if the difference between the actual and reproduced covariance matrices are within acceptable limits. What constitutes an acceptable limit is open to interpretation. However, researchers have performed extensive Monte Carlo studies that seek to develop, refine and improve upon the rules of thumb generally applied in evaluating model fit (Bearden, Sharma and Teel 1982; La Du and Tanaka 1989; Hu, Bentler and Kano 1992). These studies also provide researchers with a better understanding of how fit indices behave in certain situations. For instance, sample size and distributional misspecification are known to impact differently on certain fit statistics (Browne and Cudeck 1993; Gerbing and Anderson 1993; Tanaka 1993; Hu and Bentler 1995). Therefore, we report a menu of fit statistics on the basis that there is little consensus as to what constitutes the best overall measure of fit (Bollen 1989; Marsh, Balla and McDonald 1988; Tanaka 1993; Hoyle and Panter 1995). However, before a model can be seen as an adequate representation of the data, some consistency across several fit indices would be expected.

Insert Table 4 about here

Table 4 contains the ML and bootstrap fit statistics obtained for both the “simple” and calibrated value chain models. Power estimates are also reported using the method outlined in MacCallum, Browne and Sugawara (1996). Although statistical power is low, fit statistics for the “simple” value chain model are clearly within the suggested cut-off range. This leads us to conclude that the suggested model specification in Figure 2 is appropriate for measuring IT business value. The fit statistics for the calibrated value chain also indicate a high degree of fit. This suggests that we have successfully calibrated the “simple” value chain model. Therefore, we can proceed to use this calibration scale to derive a firm-level measure of IT business value. The non-standardized coefficients from the calibrated value chain model that will ultimately be used in determining this measure of IT business value are shown in Figure 3.

Insert Figure 3 about here

6. Application of the Business Value Thermometer

Perhaps the most useful application of the IT business value thermometer is in determining a firm-level estimate of IT business value. Using the coefficients from Figure 3, we compute a value for the IT business value latent variable of 5.069 [= (5.953 * 0.685) + 0.991]. As previously stated, this estimate can be interpreted in the context of our original 10-point Likert scale. Therefore, this value suggests that the organizations in our sample are receiving average returns from IT investment.

Insert Figure 4 about here

To further illustrate the power of our business value thermometer, we split our dataset at the median impact of IT on *Process Planning and Support* (this being the only “causal” variable in our value chain model). Figure 4 shows how firms are dramatically different across all IT business value dimensions — those whose impacts of IT on process planning and support are above the median are also consistently higher on all other dimensions of the value chain. If we apply our business value thermometer to firms on each side of the median, we find that those with impacts below the median record an IT business value measure of 4.391, compared with 6.322 for firms above the median (a difference of approximately 44%). Used in this manner, the business value thermometer can help to differentiate between firms on their ability to realize high levels of IT business value.

6.1 Exploring the Business Value Thermometer

model (Figure 2) expressly includes inter-process linkages designed to capture this effect. In order to determine whether these inter-process links are an important source of business value, we implemented a χ^2 difference test. The significance of this test ($\chi^2 = 47.506$, df = 8, $p<0.001$) suggests that these inter-process links are a valuable source of IT business value, thus justifying their inclusion in a value chain model that seeks to measure IT business value.

Notwithstanding the outcome of this test, the presence of negative coefficients on some of the inter-process links in Figure 3 is cause for concern. While our significant χ^2 difference test suggests, overall, that value is being created or enhanced as we move between processes in the value chain, negative coefficients point to the existence of bottlenecks in the value chain where value is being reduced or "destroyed" rather than created. For example, one interpretation of the negative coefficient (-0.222) between *Supplier Relations* and *Production & Operations* is that although technology is having a positive impact on supplier relations, that same technology is somehow eroding the potential for realizing IT impacts from technology deployed within the production process. Clearly, further research should be undertaken to investigate the reasons behind this counterintuitive outcome.

We also examined the calibrated value chain model to determine how IT business value would change in response to a change in the causal factors behind IT business value. Our analysis revealed that for a hypothetical one unit increase in the causal factors (say an improvement in strategic alignment), IT business value increases by 1.676. While not as interpretable as a pure dollar measure of return on investment, this 67.6% return is nevertheless encouraging. Furthermore, the impact of IT on each business process also increases to reflect the upward shift in IT business value. The increase in IT impacts for each process is shown here in parentheses: customer relations (1.110), production & operations (1.070), supplier relations (1.000), competitive dynamics (0.996), product & service enhancement (0.967) and sales & marketing support (0.889).

The analysis also reveals that customer relations is the most important dimension of IT business value. This finding comes at a time when researchers are beginning to expound the benefits of organizations practicing the “customer is king” cliché (Hammer and Champy 1993). In particular, a study by Brynjolfsson and Hitt (1996a) reports that “customer focus is the best predictor of IT value” (p. 50). They further argue that “the clearest distinction of... highly effective IT users was their focus on customer benefits like quality, flexibility, timeliness and service” (p. 50). Interestingly, they also identified customer-oriented strategies as representing the top reasons for why CIOs invest in IT.

7. Conclusion

We began this paper by proposing that IT business value could be measured by focusing on areas within the organization where value is created. The value creation process is, we argued, directly related to the pursuit of organizational goals. To achieve these goals, senior managers allocate resources across the organization based on some preconceived notion of value assessment.

We examined our proposition by assessing the extent to which executives’ perceptions of the impact of IT on business processes could serve as a measure of IT business value. Previous research had indicated that executives’ perceptions of IT closely mirror both the extent to which IT resources are used and their satisfaction with the performance of those resources. This led us to propose a value chain model of IT business value through which we could address two key questions. First, can the impact of IT on business processes within the value chain provide an appropriate structure through which to measure IT business value? Second, if process-level impacts are appropriate, how can this information be used to derive a firm-level measure of IT business value? The first question was resolved through a “simple” value chain model, while the second used a calibrated value chain model.

Our findings suggest that IT business value can be measured through the impact of IT on individual business processes. Evidence was found to support Porter and Millar’s (1985) assertion that an important source of IT-supported value-added is support for coordination between value-adding activities. In using a value chain model to generate a perception-based measure of IT business value, our analysis reveals that firms appear to be receiving average returns to IT investment.

Regardless of whether organizations are actually delivering IT business value or not, there is general agreement that the pursuit and attainment of IT business value is desirable. What is clear from this analysis is that IT business value is not merely created in isolated pockets of activity within an organization; value is also created through inter-process linkages.

Given that our estimate of IT business value is derived from executives' perceptions, an obvious question is to ask if these perceptions are borne out in an organization's financial statistics. A positive correlation between perceptual and financial-based measures of IT business value would increase confidence in both types of measures. A future extension of this research will attempt to address this issue.

Clearly IT business value is a complex multidimensional construct. A continuation of our traditional unidimensional measures of IT business value can only prolong the productivity paradox and frustrate efforts at using IT to improve organizational performance.

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Table 1. Identifying the Dimensions of IT Business Value from IT Impacts: A Review of the Research Literature

Process Planning & Support: Improve the provision of information for planning and decision making by improving organizational communication and coordination and by enhancing organizational flexibility (Galbraith 1977; Porter and Millar 1985; Bakos and Treacy 1986; Gurbaxani and Whang 1991). The impact of IT on process planning and control will impact those processes that comprise the value chain (Porter 1985).
Supplier Relations: Use IT to coordinate supplier linkages and reduce search costs (McFarlan 1984; Bakos 1991). Improved forms of communication (EDI), quality control (TQM) and delivery techniques (JIT) can lead to the establishment of a competitive advantage (Cash and Konsynski 1985; Srinivasan, Kekre and Mukhopadhdyay 1994). Improved supplier relations can have implications for the efficiency of the production process (Porter 1985).
Production & Operations: Use IT to deliver enhanced manufacturing techniques through computer-aided design (Kelley 1994). Improvements in the production process can lead to economies of scale in the deliver of products and services (Porter 1985; Malone 1987; Banker and Kauffman 1991). Incorporating technology into the end product (Porter and Millar 1985; Ives and Mason 1990), and the use of advanced manufacturing processes can enable a greater range of products and services (Pennings and Buitendam 1987).
Product & Service Enhancement: IT can be used in developing new products and services (Parsons 1983; Brooke 1991; Barua, Kriebel and Mukhopadhdyay 1995). IT can enable products and services to be uniquely differentiated in a wide variety of ways (Bakos and Treacy 1986; Brooke 1992).
Sales & Marketing Support: The development of new products and services can enable an organization to identify and serve new market segments (Pine, Peppers and Rogers 1995). IT can be used to track market trends and responses to marketing programs (Porter and Millar 1985).
Customer Relations: It can be used to establish, sustain and improve relationships with customers (Ives and Learmonth 1984). Improving customer relations can result in an improvement in market share (Parsons 1983; Porter 1985). IT can have an obvious impact on the ability of the organization to establish and defend a competitive advantage (McFarlan 1984; Porter and Millar 1985).
Competitive Dynamics: IT can alter the competitive dynamics of an industry (McFarlan 1984; Bakos and Treacy 1986). The removal of search costs can have dramatic implications for competition among industry participants (Bakos and Brynjolfsson 1993). Competitive dynamics can be influenced by successful marketing strategies, while competitiveness can be enhanced by improving product choice and cost (Porter and Millar 1985). Competitive dynamics can have significant implications for customer relations, where for instance customers react favorably to lower cost, enhanced product selection or improved responsiveness (Porter and Millar 1985).

Table 2. Confirmatory Factor Analysis - Standardized Factor Loadings

Survey Items (Appendix 1)	Process Planning & Support	Supplier Relations	Production & Operations	Product & Service Enhancement	Sales & Marketing Support	Customer Relations	Competitive Dynamics
PPS1	0.767	-	-	-	-	-	-
PPS2	0.841	-	-	-	-	-	-
PPS3	0.779	-	-	-	-	-	-
PPS4	0.751	-	-	-	-	-	-
PPS5	0.830	-	-	-	-	-	-
PPS6	0.828	-	-	-	-	-	-
PPS7	0.688	-	-	-	-	-	-
PPS8	0.815	-	-	-	-	-	-
SR1	-	0.754	-	-	-	-	-
SR2	-	0.887	-	-	-	-	-
SR3	-	0.924	-	-	-	-	-
SR4	-	0.889	-	-	-	-	-
SR5	-	0.952	-	-	-	-	-
SR6	-	0.906	-	-	-	-	-
PO1	-	-	0.925	-	-	-	-
PO2	-	-	0.933	-	-	-	-
PO3	-	-	0.809	-	-	-	-
PO4	-	-	0.816	-	-	-	-
PSE1	-	-	-	0.967	-	-	-
PSE2	-	-	-	0.974	-	-	-
PSE3	-	-	-	0.989	-	-	-
PSE4	-	-	-	0.772	-	-	-
PSE5	-	-	-	0.826	-	-	-
PSE6	-	-	-	0.769	-	-	-
SMS1	-	-	-	-	0.861	-	-
SMS2	-	-	-	-	0.878	-	-
SMS3	-	-	-	-	0.820	-	-
SMS4	-	-	-	-	0.881	-	-
SMS5	-	-	-	-	0.881	-	-
SMS6	-	-	-	-	0.927	-	-
SMS7	-	-	-	-	0.911	-	-
SMS8	-	-	-	-	0.902	-	-
SMS9	-	-	-	-	0.902	-	-
CR1	-	-	-	-	-	0.683	-
CR2	-	-	-	-	-	0.818	-
CR3	-	-	-	-	-	0.873	-
CR4	-	-	-	-	-	0.824	-
CR5	-	-	-	-	-	0.798	-
CR6	-	-	-	-	-	0.824	-
CR7	-	-	-	-	-	0.678	-
CD1	-	-	-	-	-	-	0.914
CD2	-	-	-	-	-	-	0.895
CD3	-	-	-	-	-	-	0.874
CD4	-	-	-	-	-	-	0.887
CD5	-	-	-	-	-	-	0.786
Variance Explained	62.2%	78.8%	76.2%	78.9%	78.4%	62.2%	76.1%

Table 3. Convergent and Discriminant Validity, with Reliability Estimates

Dimensions of IT Business Value	1.	2.	3.	4.	5.	6.	7.
1. Process Planning & Support	0.623						
2. Supplier Relations	0.393	0.786					
3. Production & Operations	0.386	0.236	0.759				
4. Product & Service Enhancement	0.368	0.295	0.479	0.785			
5. Sales & Marketing Support	0.433	0.432	0.345	0.437	0.782		
6. Customer Relations	0.564	0.448	0.398	0.381	0.382	0.619	
7. Competitive Dynamics	0.430	0.372	0.471	0.428	0.501	0.575	0.759
Composite Reliabilities	0.929	0.956	0.926	0.956	0.970	0.919	0.940

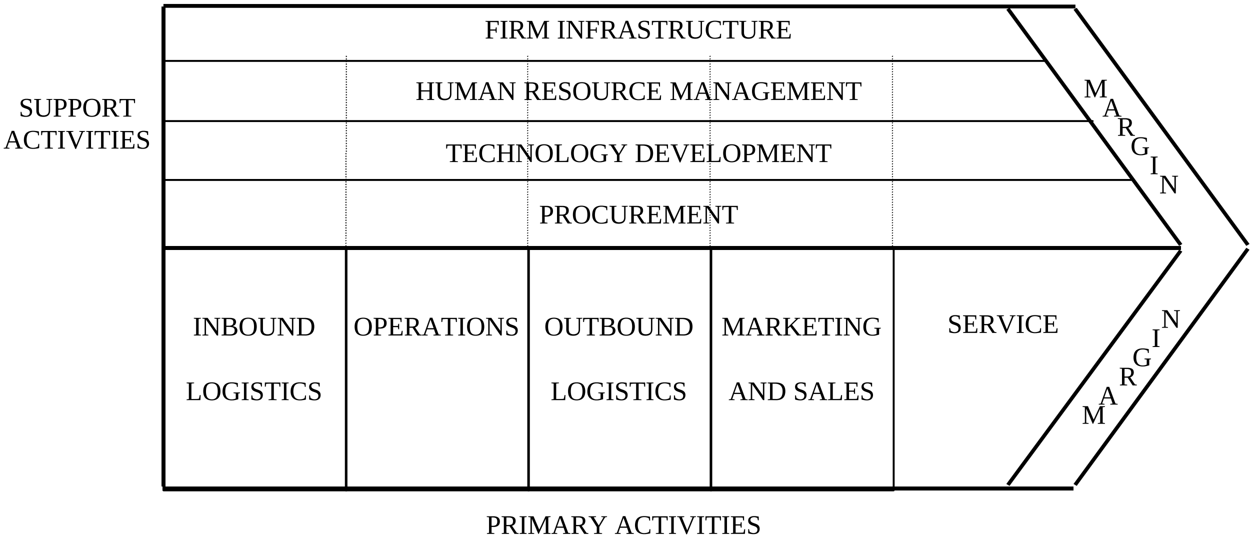
Note: Diagonal elements indicate variance extracted while off-diagonal elements indicate shared variance.

Table 4. Fit Statistics and Power Estimates

	Required for Good Fit	Simple Value Chain Model		Calibrated Value Chain Model	
		ML Est.	Bootstrap	ML Est.	Bootstrap
Chi-square χ^2	-	2.289	12.489	16.242	37.113
p value (for χ^2)	$p > 0.05$[1]	0.891	0.052	0.093	< 0.001
Satorra-Bentler Scaled χ^2	-	1.376	7.934	n/a	n/a
p value (for scaled χ^2)	$p > 0.05$[1]	0.967	0.243	n/a	n/a
Normed Fit Index (NFI)	≥ 0.90[2]	0.997	0.986	0.981	0.959
Non-normed Fit Index (NNFI)	≥ 0.90[2]	1.015	0.974	0.985	0.943
Comparative Fit Index (CFI)	≥ 0.90[3]	1.000	0.992	0.993	0.970
Goodness-of-Fit Index (GFI)	≥ 0.90[4]	0.996	0.981	0.930	0.893
Root Mean Sqr. Err. of Approx. (RMSEA)	0.08[5]	0.000	0.067	0.059	0.112
Power Estimate	≥ 0.80[6]	0.460		0.614	

The “simple” value chain model has 6 degrees of freedom, the calibrated model has 10. Bootstrap fit statistics are based on the mean of 1000 replications. EQS v5.2 does not evaluate Satorra-Bentler χ^2 statistics in structured mean modeling.

1. Bentler (1995); 2. Bentler & Bonett (1980); 3. Rigdon (1996); 4. Hu & Bentler (1995); 5. Browne & Cudeck (1993); 6. Cohen (1988)



Source: *Competitive Advantage: Creating and Sustaining Superior Performance*
by Michael E. Porter, 1985, The Free Press

Figure 1. The Generic Value Chain

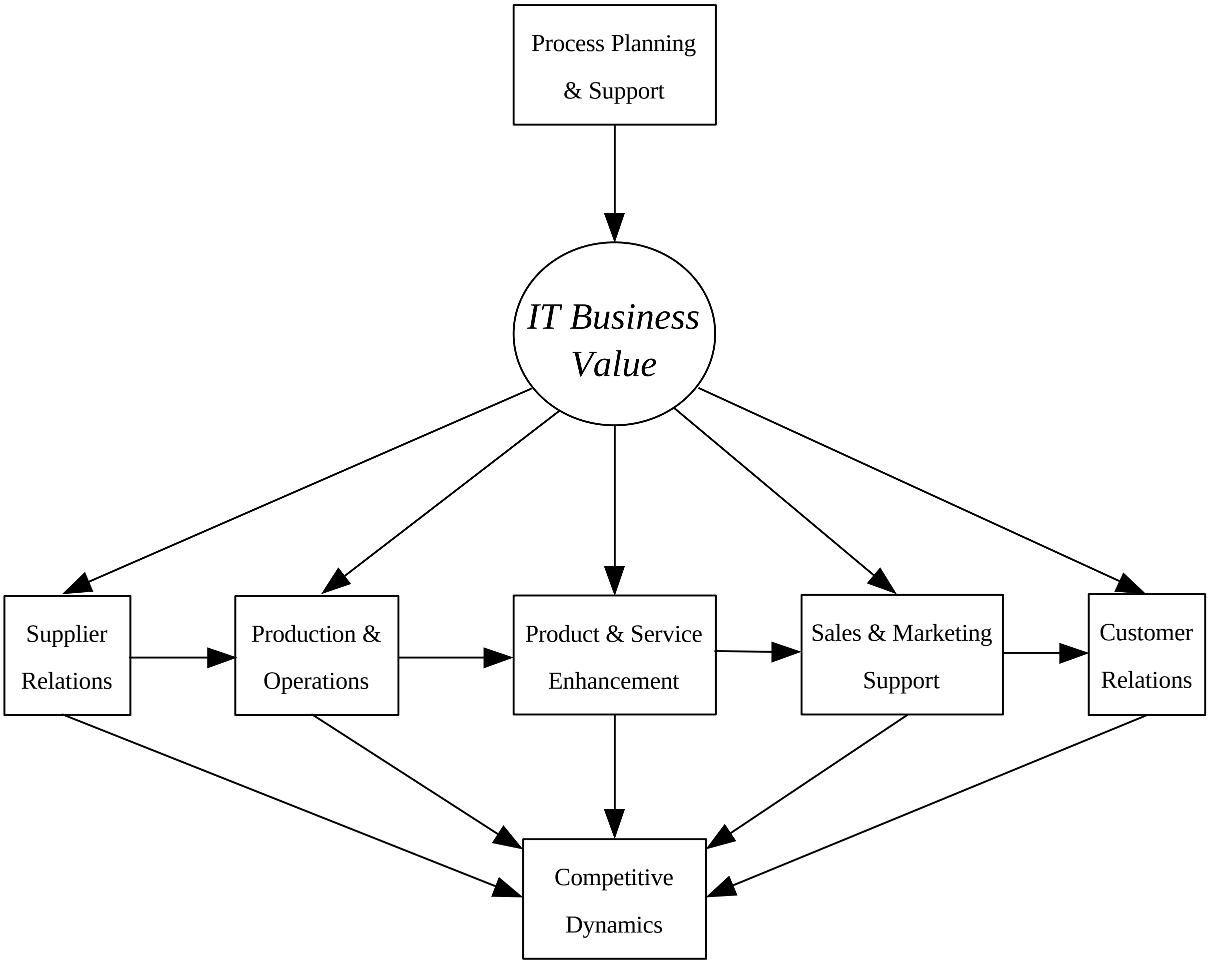
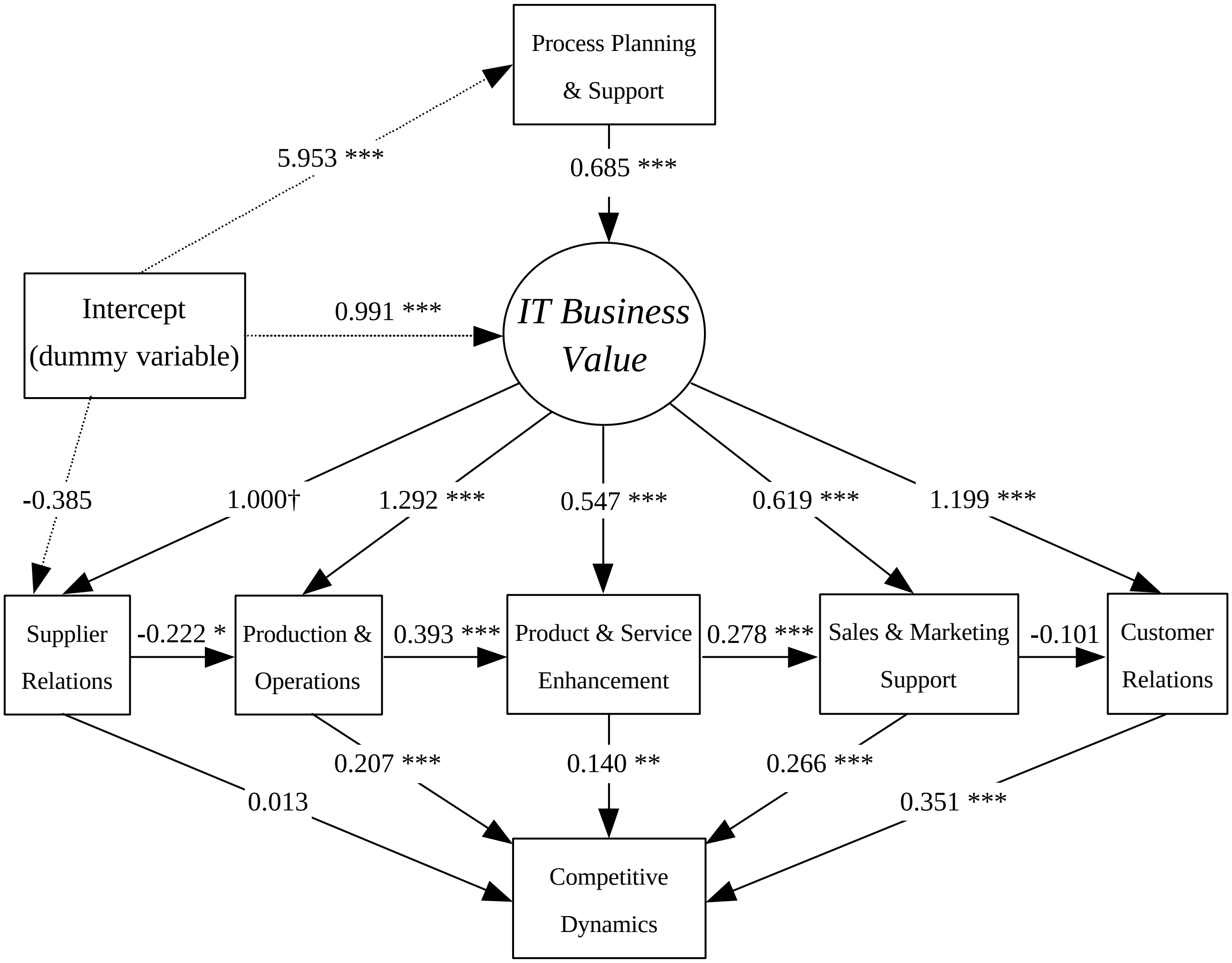


Figure 2. Value Chain Model of IT Business Value



Note: *** $p<.001$, ** $p<0.01$, * $p<0.05$; † fixed at 1.000; disturbance terms have been omitted.

Dashed lines are not part of the original value chain model, and are only included here as a means of "anchoring" the dummy variable to the value chain and the IT business value latent variable.

Figure 3. Non-standardized Coefficients of the Calibrated Value Chain Model

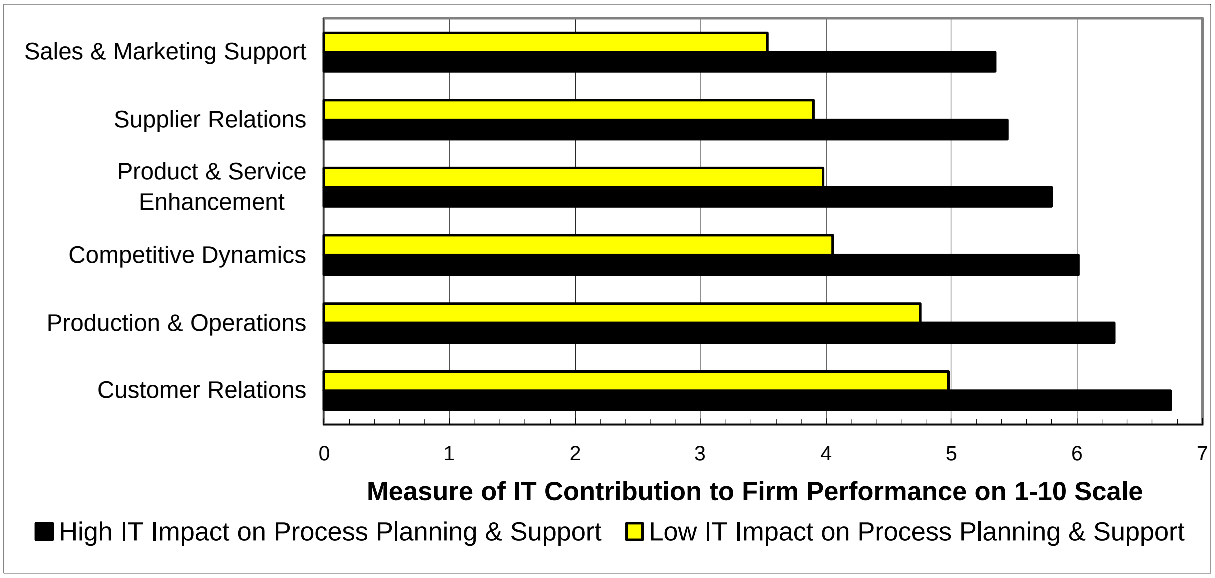


Figure 4. Business Value Dimensions by Median IT Impact on Process Planning & Support

APPENDIX 1.

Survey Instrument: Items Used to Measure Each Dimension of Business Value

To what extent does information technology contribute to overall performance of your firm along each of the following dimensions? Please restrict your appraisal to realized, not expected benefits.

Low Realized Impact   High Realized Impact

1 2 3 4 5 6 7 8 9 10

Process Planning & Support

PPS1	Facilitate the automation of core business processes
PPS2	Improve the process and content of decision making
PPS3	Improve internal communication within your corporation
PPS4	Improve strategic planning
PPS5	Provide better coordination among functional areas in your corporation
PPS6	Facilitate implementing new processes that constitute a better way of doing business
PPS7	Improve coordination among geographically separate units of your corporation
PPS8	

CR6 Position customers to rely increasingly on your corporation’s electronic support systems
CR7 Provide on-line access of your corporation’s products/services to customers

Competitive Dynamics

CD1 Support your corporation in offering a product/service that your competitors cannot immediately match
CD2 Help your corporation to provide substitutes for your competitors’ products/services
CD3 Help to delay competitor entry into your corporation’s product/service areas because of new investments required in information technology
CD4 Make it easier to capture distribution channels and thereby increase the cost and difficulty for competitors to enter a new or existing market segment
CD5 Provide your corporation with unique opportunities for product and service innovation

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