The Deficiency of IT Capability of A Firm Vis-À-Vis Competition and IT Outsourcing Decisions: A Two Stage DEA and PLS Analysis

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Abstract

This research in progress addresses the issue of how IT capabilities of firms can influence their IT sourcing decisions. Drawing from strategic theoretic views, the research model is developed to argue that firms engage in outsourcing of their strategic IS activities based partly on the relative efficiency (with respect to their competitors) of their key IT input resources and factors, in addition to other drivers including their imitative response following industry trends in this regard. The paper develops hypotheses with respect to the impact of the relative efficiencies of three key input factors – business-aligned IS planning, IS knowledge acquisition, and top management’s proactive use of IS – on the significant outsourced IS activities that contribute to competitive action potential of a firm. Data is collected using the survey method and a two-stage DEA-partial least squares (PLS) approach is employed to validate the framework. An “efficiency score” using DEA for capturing a relative level of IT competence of firms will be generated, which will further guide a firm as to whether or not it needs to fill the gap through outsourcing arrangements.

Keywords: Relative efficiency, IT outsourcing, DEA, PLS
1 INTRODUCTION

Most prior research on the outsourcing phenomenon has investigated IT sourcing decisions in the general context, empirically examining the determinants, grounded primarily in the transaction costs economics (TCE) literature (Williamson 1979). These typically, do not explain how IT sourcing is made vis-à-vis competition. Some studies have used the lens of strategy literature to examine IT sourcing decisions with respect to industry comparisons (Grover et al. 1997). Others have investigated institutional influence on sourcing decisions (Ang and Cummings 1997). Teng et al. (1995) employed capability discrepancies measured relative to the requirements of the firm but not relative to the industry. The theoretical premises of the strategy literature, particularly the resource-based view (RBV) (Barney 1986; Dierickx et al. 1989) hinge upon the concept of relative existence of resources/capabilities vis-à-vis competition. In line with this view, we argue that companies frequently assess themselves with respect to their competitors to see if their IT capabilities can be used to better position themselves in the market and when they detect deficiencies vis-à-vis competition, outsourcing decisions are made to close this gap. This leads to the fact that firms’ outsourcing decisions go beyond imitation and self-examination and thus further attention is needed to understand how IT sourcing decisions are made relative to competition in the market. This paper focuses on IT sourcing as a function of relative deficiencies (efficiencies) of IT resources/capabilities of the client firms with respect to the peers in the same industry and then identifies how the areas of deficiencies lead to outsourcing of specific IT activities to realize the strategic value that could be brought in by outsourcing engagements.

In this paper we, therefore, investigate the impact of relative efficiency of three key factors – business-aligned IS planning, IS knowledge acquisition, and top management’s proactive use of IS – on firms’ IT outsourcing decisions with respect to their strategic IS activities. The major research question this paper addresses is: What is the impact of relative efficiencies of key IS capabilities and organizational factors on firms’ outsourcing of their strategic IS activities that possess a high degree of competitive action potentials? This research question is investigated in this paper through a survey of firms who have at least one outsourcing contract with an IT services provider. This study employs a two-stage modeling approach that combines the data envelopment analysis (DEA) and the partial least squares (PLS). This approach of measuring the relative efficiency of IT capabilities vis-à-vis competition using DEA method is an objective way for understanding IT outsourcing decisions.

2 BACKGROUND

Over the past decade researchers have investigated IS outsourcing decisions drawing on various theoretical traditions. Typically, IS outsourcing decisions have been investigated mainly from the perspective of transaction cost economics (TCE) (Williamson 1987). While these have largely dealt with efficiency of market transactions and of governance forms as factors that affect IS outsourcing decisions (Ang and Straub 1998; Nam et al. 1996), these explanations center on transaction characteristics and static efficiency and examine the effects of exchange conditions on a make-or-buy choice rather than on comparative institutional performance. Other streams of research have focused on institutional influences on IT sourcing decisions based on the social perspective (Ang et al. 1997) and the innovation diffusion perspective (Hu et al. 1997), and strategic decisions based on a strategic management perspective (Teng et al. 1995). A review of prior literature reveals that IS outsourcing decisions have been examined with respect to two drivers, industry comparisons and capability discrepancies. The diffusion of innovation approach basically looks at internal (community) influence as a driver of outsourcing. It argues that a potential adopter looks at the community of adopters and adopts the innovation if his/her peers are adopting an innovation. Thus, firms actually imitate the peers in the industry based on an industry comparison. The second driver looks at capability discrepancies but these have been investigated only in terms of self-examination by users/IT people of a firm. Teng et al. (1995) carried out a gap analysis between the desired IT performance and perceived actual internal IT capability, and described the outsourcing decision based on this internal discrepancy. However, this evaluation of capability discrepancies is an appraisal relative only to the requirements of the firm but not relative to the industry.
Because IT-based strategic advantages are short-lived, until imitated or substituted by a competitor, firms frequently assess their IT capabilities relative to their industry (competitors). Thus, we argue that it is critical for firms to inquire into two critical issues in their IS sourcing decision-making processes; 1) whether they possess superior (or inferior) IS capabilities with respect to the competition so that they can support businesses to be successful in the market, and 2) whether IT activities to be delivered by the external service provider have a strategic value to their business processes. In other words, if there is relative deficiency of IS capabilities to the competitors and if specialists may offer a way to access the expertise, outsourcing may be a viable option to shape the agility of firms (Sambamurthy et al. 2003).

The competitive thrusts underlying the IS outsourcing decision, as discussed above, suggest that the decision may be explained from a competitive advantage perspective. Given the strong appeal of the competitive advantage perspective, this study attempts to examine the IS outsourcing decision on the basis of relative competitiveness in the industry, which has not been explored in previous studies.

3 IS OUTSOURCING AS A COMPETITIVE ACTION

It is widely accepted that IT-based strategic advantages are only short-lived, until imitated by a competitor so the industry players must compete by seizing a series of short-term advantages through many competitive actions (Sambamurthy et al. 2003). In order to enhance competitiveness, Grant (1991) argues that a firm is not restricted to exploiting only its existing stock of resources and capabilities. It is also encouraged to externally acquire capabilities (i.e., outsourcing) necessary to fill capability gaps because outsourcing arrangements enable firms to exploit market opportunities through efficient sourcing of assets, capabilities, and knowledge in order to capture positions of advantage (Dyer and Singh 1998). Thus, we consider relative inefficiency of IS capabilities of firms to competition as a critical antecedent for firms to fire competitive actions (outsourcing decisions).

Though relative efficiency (or deficiency) of IS capabilities of firms may have significant influence on outsourcing decisions, a critical issue is whether the concept of relative level of IT competence vis-à-vis competition can be parameterized in a way that makes it possible to generate testable empirical assertions (Priem and Butler 2001). Especially problematic is that while the theoretical premise hinges on the concept of relative level of IT competence vis-à-vis competition, capability formations in RBV literature have typically defied empirical evaluation due to the company-specificity of the process. Clearly the process must be company-specific to be of any use in generating quasi-rents. Otherwise, capabilities are no longer inimitable and thus cease to be the sources of the rent. The evaluation of such capabilities should be explicated in relative terms: that is, relative to competition and market. We propose to resolve this issue using the following two stage approach: In the first stage, the relative efficiency of each organization with respect to IS capabilities is evaluated through Data Envelopment Analysis (DEA) (Charnes et al. 1994) based on data about their IS units’ activities as inputs and performance as output. In the second stage, using partial least squares (PLS), the efficiency score is then regressed on the potential strategic values of IS activities outsourced to identify which area of inefficiency (or deficiency) have significant impacts on outsourcing decisions and are associated with types of strategic values that the outsourced IS activities are intended to deliver (Banker and Natarajan 2003). In the next section, we develop several testable hypotheses emanating from the general proposition presented in the previous section.

4 MODEL AND HYPOTHESES

In the early and mid 90s it was often argued that the strategic value of IS activity was, in general, expected to affect the sourcing decision negatively and limit sourcing only to non-core IT functions because sustainable long-term competitive advantages couldn’t be offered by means of outsourcing (Earl 1996). However given the current market situation, firms are required to be agile to respond to market opportunities, engender fast time-to-market, and provide a product/service bundle in a timely fashion efficiently (Kalakota and Konsybski 2000). Thus, sourcing IT resources and capabilities is no
longer simply a core/non-core issue; but is utilized to manage innovation, and to deliver processes and services effectively and efficiently to the internal organization, business partners, and clients or constituency in order to leverage business opportunity in the market (Rold 2001). In fact, it has been demonstrated that the motivations for outsourcing are evolving from a primary focus on cost reduction to an emerging emphasis on improving business performance (Teng et al. 1995). Outsourced IT activities are viewed as ‘strategically valuable’ when they exploit opportunities hidden in the organization as well as the market and avoid economic losses (Barney 1991; Mahoney and Pandian 1992). Therefore, the issue is whether these technologies are able to exploit the market and organizational opportunities and produce valuable outcomes in terms of market posture. Firms try to position themselves to gain competitive advantages in the market. They assess their relative capabilities to their competitors in the market. If they find their capabilities inefficient vis-à-vis competition we argue that they would be drawn to outsourcing specific IS activities that would bring strategic values such as enhancement of existing lines of businesses through product or services development and enhancement, market exploitation, and operating efficiency (DiRomualdo and Gurbaxani 1998). Therefore, we propose that the strategic values of IS activities brought in by the external providers are related to the areas of inefficient capabilities.

4.1 Business-Aligned IS Planning

The ability of an organization to anticipate and respond to business opportunities is the one of the most important ways in which its competitiveness and viability are ensured. IS capabilities lead to business value through their impact on a firm's IS planning, delivery, and operations and support processes to the business needs (Ross et al. 1996). To the extent that these processes are strategically aligned, fast, and cost effective, they result in competitively important IT-enabled business processes (Tanriverdi et al. 2007). Senior executives, strategic planners, and IS managers have turned their attention to opportunities for achieving competitive advantage through the integration of IT strategic planning with the overall strategic planning of the firm (Oh and Pinsonneault 2007). To enhance its contribution to corporate profitability the IS unit must address business units’ concerns with end-to-end availability as well as operational efficiency of applications used in business processes and in service quality in its strategic planning. This requires enterprises must resort to close linkages between the IS organization and the business units to gain this understanding.

In general, firms whose IS units are intricately woven into business units are regarded to be able to (a) integrate the IT and business planning processes more effectively, (b) conceive of and develop reliable and cost effective applications that support the business needs of the firm faster than competition, and (c) anticipate future business needs of the firm and innovate valuable new product features before competitors, thus resulting in quick market exploitation (Bharadwaj 2000). For these firms, Ross et al. (1996) suggest that IT executives, with their business counterparts, should constantly assess the status of the relationship between IS units and business units and have the capabilities to develop strategies to attack weaknesses and leverage strengths. If firms lack such capabilities as compared to competition, these firms would require risky, often expensive moves to speed up a process that is evolutionary in nature. In order to quickly build IT skills or transform a weak technology infrastructure, a firm would have to enter an outsourcing agreement. Therefore, the relative deficiency of business-aligned IS planning will lead to IS outsourcing decisions. In particular, this approach of outsourcing decisions leads firms to outsource IS activities seeking for three strategic benefits: products/services development and enhancement, market exploitation, and operating efficiency. Therefore, we hypothesize:

**Hypothesis 1a:** Outsourcing decisions regarding IS activities that contribute to products/services development and enhancement are negatively related to the relative efficiency of business-aligned IS planning and decision-making.

**Hypothesis 1b:** Outsourcing decisions regarding IS activities that contribute to market exploitation are negatively related to the relative efficiency of business-aligned IS planning and decision-making.

**Hypothesis 1c:** Outsourcing decisions regarding IS activities that contribute to operating efficiency are negatively related to the relative efficiency of business-aligned IS planning and decision-making.
4.2 IS Knowledge Acquisition

Knowledge acquisition is defined as the organizational or individual activities to acquire information or knowledge that is potentially useful to the organization (Huber 1991). It is well known that a firm’s IS capabilities critically relate to its capacity to recognize the value of new, external skill sets, assimilate it, and apply it to commercial ends (Cohen and Levinthal 1990). This active learning improves firm’s absorptive capacity (Cohen et al. 1990; Lane et al. 2001) which in turn mitigates the fear to adopt new technology. According to Roepke et al. (2000), aligning the IT human resource with business vision requires skill sets for IT professionals and IT leaders and the capacity to develop and leverage this human capital in support of business needs to translate the vision to reality. Keeping abreast of the latest IT developments through active knowledge acquisition by the client firm is critical in maintaining competitive advantages, by exploiting markets, enhancing operating efficiency, and service quality enhancement in the industry. A case in point is the study by Ang (1997), who found that many banks seemingly lacked the internal IS ability to cope with increasing functional complexity. Lacking systems integration skills, banks outsourced their IT functions to specialized external IS service providers in order to respond to the peer pressure.

We therefore argue that a firm’s self-sufficiency in IT skills, and its availability of required expertise from in-house IT personnel, can be generally expected to have a negative effect on initial adoption of outsourcing (Loh and Venkatraman 1992). In contrast, if firms are relatively weak in this regard as compared to the competitors, they might want to either source appropriate skills or expertise as quickly as possible to expedite the process of knowledge acquisition (Nohria 2005). While active knowledge acquisition gets firms rolling more effectively in deployment of IT projects, pursuing the latest technology in business requires the firms to put efforts in terms of time and/or personnel. More complex services will require more detailed knowledge. It takes time to develop this knowledge internally, which will risk the firm’s agility in the competition (Sambamurthy et al. 2003). Therefore, the need for access to new or superior technology, particularly if time-to-market were critical, may drive a firm into an outsourcing arrangement. The opportunity to learn skill sets brought in by the vendor also leads firms to outsourcing engagements. Moreover, the acquisition of vendors’ expertise will expedite the stabilization process of newly adopted IS, enabling the firm to more quickly respond to strategic needs. We therefore argue that a firm with relative deficiency of knowledge acquisition will find a favor with IT outsourcing decision. To explore the strategic action potential, outsourcing decisions lead firms to outsource three areas of IS activities including products/services development and enhancement, market exploitation, and operating efficiency. We, therefore, hypothesize the followings:

Hypothesis 2a: Outsourcing decisions regarding IS activities that contribute to products/services development and enhancement are negatively related to the relative efficiency of knowledge acquisition.

Hypothesis 2b: Outsourcing decisions regarding IS activities that contribute to market exploitation are negatively related to the relative efficiency of knowledge acquisition.

Hypothesis 2c: Outsourcing decisions regarding IS activities that contribute to operating efficiency are negatively related to the relative efficiency of knowledge acquisition.

4.3 Top Management’s Proactive Use of Information Systems (IS)

Rapidly changing corporate environments make business requirements a moving target, where the agility of firms to aim theses needs is desired. To engender competitiveness in the market, an important mechanism is to introduce IS innovations before or as soon as competitors do (Quinn 2000). Thus, top management often shows keen awareness of importance of IS in the business processes and encourage to proactively use IS assets, thereby shaping a competitive market posture. To ensure that limited resources are invested wisely, top management must be involved in establishing IS priorities (Ross et al. 1996). While top management articulate how IS should support business or corporate strategy, the insight grows from accumulated top management’s experiences, organizational intelligence about emerging information technologies and their business potential, and alertness to competitive actions by rivals (Sambamurthy et al. 2003). It helps make sound judgment,
and often resourcefulness, especially in practical matters. In fact, top management’s proactive use of IS is developed over time through a series of linked strategic decisions about the sourcing of information technologies and the blending of information technologies with organizational processes and knowledge (Barua and Mukhopadhyay 2000). Obviously, senior executives can choose from a wide range of strategic alternatives in deciding how to source capabilities to gain a competitive edge. If top management were insightful to identify opportunities for IT-enabled business processes and to realize the necessity to grasp short-lived competitive advantages agiley, the IT unit would not just restrict to source resources/capabilities internally. Rather, it seeks for various channels to dynamically source lacking capabilities. Thus, proactive CIOs who identify opportunities to seize market arbitrage are often actively involved in effective sourcing decisions through market governance. As real-time needs become more critical and enterprises focus more attention on end-to-end business processes, organizations will need to reduce the time they take to source and deploy IT solutions - regardless of whoever provides them (Sweeney 2001). Moreover, as is well-known, the rate of technological innovation and change has been relentless for more than a decade and the period of enjoying competitive advantages only seems short-lived till competitors deploy the same IS. Therefore, top management that plans to execute their IS project to support business requirements in a swift and expeditious manner, are essentially signaling their commitment to utilize best practices in project management to mitigate the environmental turbulence and technology obsolescence risks. In this sense market governance and outsourcing may provide valuable resources for rapid execution. Firms often hire vendors to help them respond to rapidly changing business and technology needs in the presence of rising salaries and turnover. As such, top management’s proactive use of IS may offer a sharp intelligence and often an intuitive grasp of practical considerations. Thus, top management with superior capability profile and insight of proactive use of IS vis-à-vis competition will not restrict to resort to insourcing over outsourcing. In contrast, top management with relatively weak capability profile in proactive use of IS could easily lead the firm to investments in developing capabilities internally though the delivery of necessary IS to compete might not be timely and their benefits might not be easily quantifiable. Therefore, relative efficiency of top management’s proactive use of IS will be more likely drawn toward outsourcing strategy. Thus we hypothesize:

Hypothesis 3a: Outsourcing decisions regarding IS activities that contribute to products/services development and enhancement are positively related to the relative efficiency of top management’s proactive use of IS.

Hypothesis 3b: Outsourcing decisions regarding IS activities that contribute to market exploitation are positively related to the relative efficiency of top management’s proactive use of IS.

Hypothesis 3c: Outsourcing decisions regarding IS activities that contribute to operating efficiency are positively related to the relative efficiency of top management’s proactive use of IS.

Figure 1 below summarizes the above discussion.

Figure 1. Research Model and the Hypothesized Relationships
5 RESEARCH METHOD

5.1 Data

Data was collected through questionnaires using a large-scale mail survey method. A list of IS professionals was obtained from Directory of Top Computer Executives. 800 questionnaires were sent to top IS managers in the U.S. In total, 154 usable questionnaires were received representing a response rate of 19.25%, which was close to the minimum recommended level of 20% for organizational survey (Yu and Cooper 1983). Among these respondents, 93 cases corresponded to the category of outsourcing and the remaining 61 cases represent insourcing. We first checked the respondent bias. For this test, we randomly selected 50 firms from non-respondent firms and respondent firms respectfully and compared their total assets, net sales and the number of employees (Cheon 1992; King and Sabherwal 1992). No significant differences were found between respondents and non-respondents at a 5 percent level.

5.2 Analysis: Two-Stage DEA-Partial Least Squares (PLS) Approach

The strategic management approach provides a complementary perspective on IS sourcing decisions. While Duncan (Duncan 1998) evaluates the risk associated with outsourcing grounded on the RBV, she concludes her paper by indicating the scarcity of empirical work using this approach. To aid on IT sourcing decision, we will employ the combined approach in a two-stage manner. In a recent study by Arnold et al. (Arnold et al. 1996; Barr et al. 1993; Shao and Lin 2002) introduced a new way to combine the DEA and regression approaches in a two-stage manner. We here further build on this approach by combining the DEA and the PLS approach as follows: DEA is first used to identify which decision making units (DMU) are efficient and inefficient. These results are carried over in the form of indicator variables forming a construct of the presence of strategic resources/capabilities, which are then incorporated in the PLS.

5.2.1 Stage 1: Estimating Efficiency Scores Using DEA

While the DEA efficiency metric has proved to be a good proxy for capturing the efficiency of performance, such as managerial quality (Barr et al. 1993), knowledge worker performance (Paradi et al. 2002), efficiency of resource utilization (Majumdar 1998), supplier evaluation in the context of supply chain management (Narasimhan et al. 2004), application of DEA in IS research has been limited. The current study employs Majumdar’s (1998) approach of measuring the strategic performance of firms using the resource utilization index. The ability of firms to utilize resources is regarded as a key indicator of their competitive abilities. This therefore allows the use of DEA efficiency scores as variables in IT sourcing decision models. In line with this approach, this paper considers different dimensions of IT resource utilization for firms in the manufacturing industry and computes a scalar measure of efficiency using DEA. This measure of transformational efficiency is derived using a multiple-input, multiple-output model in DEA and considered a proxy for competitive ability.

DEA optimizes each individual observation with an objective of calculating a discrete piecewise frontier determined by the set of Pareto-efficient DMUs. DEA handles multiple outputs and inputs and estimates the amount of inefficiencies in each input or output for every observation and the DMU associated with these observations. We include four sets of IS inputs (IS influence in strategic IS decision-making, business-aligned IS planning and decision-making, knowledge acquisition, and top management’s proactive use of IS) and one set of output representing the perceived IS performance by the top management of the firms. The “efficiency scores” are estimated by solving a set of LP models, one for each DMU. We utilize the output-oriented DEA model known as CCR model as a basis (Charnes et al. 1994). The efficiency scores ($q_0$) for a group of peer DMUs ($j=1, \ldots, n$) are computed for the selected outputs ($y_{rj}, r=1, \ldots, s$) and inputs ($x_{ij}, i=1, \ldots, m$). The models are transformed into an LP model as follows (Banker et al. 1984; Charnes et al. 1994; Charnes et al. 1978; Giokas and Pentzaropoulos 2000):

$$\text{Min } q_o = \sum_{r=1}^{s} u_r * y_{ro}$$
Subject to \[ \sum_{j=1}^{m} v_i x_{io} = 1 \]
\[ \sum_{j=1}^{s} u_r y_{rf} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \quad u_r, v_i \geq \varepsilon \]

\( u_r \) and \( v_i \) are the virtual multipliers for the outputs and inputs respectively and “\( \sigma \)” denotes the focal DMU whose score is being calculated. It should be noted that input and output values as well as all multipliers are assumed to be greater than or equal to epsilon (\( \varepsilon \)), a non-Archimedean (infinitesimal) constant. DEA then provides efficiency scores by capturing the efficiency in converting the input sets into the outputs, in other words, the process of transforming IS resources into relative IS performance of DMU in the manufacturing industry under investigation. Because they are generated in relation to all the other DMUs in the homogeneous group, the calculations produce relative efficiency measures (Charnes et al. 1994).

Although DEA solutions generally require solving a linear program (LP) for each DMU, calculations with standard LP software are subject to inaccuracies because of the risk of degeneracy even for small datasets (Ross and Droge 2002). Therefore, this study used EMS version 1.3, which uses the LP solver, BPMPD but provides more options to appropriately generate efficiency frontiers. All models assume constant returns-to-scale because the evaluation units, which are IS departments in this study, would be of similar functionality in the homogeneous data pool (i.e., manufacturing industry) (Charnes et al. 1978), therefore allowing for a more narrow band scale within the analysis. In addition, maxAverage distance was employed, quantifying the maximal average of relative improvements (input reduction/output increase measured in percentages of the current level). With these options, DEA will be performed to estimate efficiency scores of each decision making unit (DMU) for each area of capabilities of the firms, respectively.

5.2.2 Stage 2: Testing Hypotheses using PLS Analysis

In stage two, we will then estimate relations employing a PLS with a ratio dependent variable as an outsourcing decision (i.e., outsourcing budget as percent of total IS budget) (Teng et al. 1995) in which the DEA efficiency scores from the first stage serve as one of independent variables in the second stage PLS model. As indicated by Loh and Venkatraman (Loh et al. 1992), we believe that the sourcing of IT/IS portfolios may no longer be considered as a single dichotomous decision. Therefore, a continuous measure (i.e., outsourcing budget as percent of total IS budget) is utilized as a dependent variable to capture today’s outsourcing practices, which involve complex arrangements and varying degrees of coverage for a firm’s activities (Teng et al. 1995).

The research model is being tested using the structural equation modeling technique of Partial Least Squares (PLS), which is well suited for complex predictive model (Lohmoller 1989; Wold 1982). PLS has several strengths that made it appropriate for this study, including its ability to handle small sample sizes and dealing with potential multicollinearity problems (Chin 1998). PLS analyzes measurement and structural models with multi-item constructs that include direct and interaction effects (Chin et al. 1996). There are several excellent examples of the use of PLS in IS research (cf. (Compeau and Higgins 1995a; Compeau and Higgins 1995b; Ravichandran and Rai 2000; Sambamurthy and Chin 1994; Venkatesh 2000; Wixom and Watson 2001).

Before testing for the structural model, we inspect whether the measurement model had a satisfactory level of validity and reliability (Fornell and Larcker 1981). Working within this context, PLS Graph (version 3.0) is utilized as the analytical tools for testing and estimating the measurement models discussed in the followings.

6 RESULTS

Results will be presented at the conference.

References:

Space limitations preclude a complete list of references cited, which is available upon request.