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In Search of Information Technology Business Value: Do Measurement Levels Make a Difference?

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Abstract

Measuring the business value of organizational decision support systems (ODSS) is challenging because although the DSS effectiveness has generally been measured at the individual level, the literature measuring the impact of IT has recently been recommending deeper analysis into the firm or process level. This research in progress will examine the impact of ODSS at process level among seven hospitals and compare the findings with the impact of information technology investment at the firm level.

Keywords: Organizational decision support systems, firm level, process level, business value of information technology, institutional decision support systems, Huber's advanced information technology theory

Introduction

The role of information technology (IT) in enhancing the effectiveness of the organization has been a topic of discussion and often discord among academicians. Increasing investments in IT continue to increase the importance of the topic for researchers as well as practitioners. Yet, there does not appear to be a consensus on what and how to measure the organizational value of technology.

The discord occurs due to differing measurement beliefs in the extant literature in decision support systems (DSS) and organizational studies (OS). The belief that IT leads to organizational effectiveness is especially contentious for DSS which are designed primarily to support individual decision making. This raises questions about the aggregation of benefits resulting from individual use in creating organizational effectiveness (Bregman 1995). Similarly, organization theorists raise the question of whether organizational effectiveness can even be measured meaningfully (Mohr 1982). Given that an underlying objective of organizational research is to generate a generalizable theory, measurement of a phenomenon lies at the heart of the theory construction. Nevertheless, Orlikowski and Barley (2001) propose that OS and IT can learn from each other, particularly for studies examining the impact of IT on organizations.

In this paper we draw upon the OS literature to frame the challenge of measuring organizational effectiveness resulting from IT investment. Using Huber's theory of advanced information technologies (AIT) we examine the impact of an organizational DSS (ODSS) on the outcomes of the user organizations' design, intelligence and decision making (Huber 1990). Huber's AIT theory is particularly well suited for our ODSS context because it proposes a framework to study the impact of the availability and usage of AIT upon organizations. Huber also suggests that as the uses and capabilities of the decision-aiding technologies increase, researchers should reassess what is known about these technologies (Huber 1990). Given that in our research setting the ODSS has been in place for a number of years and its use within organizations is deeply entrenched, it is appropriate to reexamine the expectations and assumptions from initial research at the time they were developed.

By incorporating findings of the extant literature in IT business value (Brynjolfsson and Yang 1996; Kohli and Devaraj 2003b; Mahmood and Mann 1997) and the research stream of DSS effectiveness (Forgionne and Kohli 2000; Keen 1981; Nault and Benbasat 1990; Sharda, Barr and McDonnell 1988), the goal of this research is to apply the learning to that of the value of ODSS to the organization. In doing so, we gather process level data from seven hospitals and examine ODSS impact on organizational outcomes by using Huber's theory of AIT.

Theoretical Foundation

In this section we review the theoretical foundations in which this study is grounded. We draw upon the literature of DSS impact on decision-making and the availability of advanced technologies on improved performance. We also draw upon the rich literature from organization studies to examine the role of DSS technology in an organizational context. The success or failure of information technologies largely depends upon its organizational adoption and usage.

DSS are traditionally used by individuals to deal with semi-structured decision scenarios by structuring the problem, generating alternatives and establishing a criteria for choosing the optimal alternative (Simon, Egidi and Marris 1992). Given the focus on individual decision making and their preference to use or ignore the recommendation, McLean and Riesing concluded that DSS were discretionary and need not extend beyond the individual decision making needs (McLean and Riesing 1977). Perhaps this conclusion was based upon the narrow definition that DSS were designed to suit an individual's decision scenario. Nevertheless, contrary to this early view of how DSS can and should be used, DSS were expanded to support group decisions and called Group DSS (GDSS). Later studies developed GDSS evaluation criteria for by including voting by group members, conflict resolution, and negotiation (Adkins, Burgoon and Nunamaker 2003; Eden 1995; Tyran, Dennis, Vogel and Nunamaker 1992).

Information Technology Business Value		
Level of Analysis	*Strengths*	*Weaknesses*
Economy	• Any investment should improve overall productivity of the economy • With enormous investments, the stakes are higher than for any single organization	• Inherently contain measurement 'noise' resulting in mixed results • Poorly performing firms negate the benefits of higher performance firms
Organization (Firm)	• Findings result in actionable recommendations • The investment should eventually firm add value to the firm	• Intra-firm activities can compete with each other to mitigate organizational benefits • Strategy-IT misalignment can obliterate business value
-------- Operational Level -------		
Department/ Process	• Conversion contingencies reside at the department or process level • Process improvements contribute to the organizational improvements	• DSS do not support a department or process directly, only through improved individual decision-making • Processes involve many individuals and DSS should take into account potentially conflicting decisions and varying risk criteria
Individual	• DSS are designed to support individual decision making by supporting human decision making processes • DSS also improve human decision making abilities by supporting creativity and what-if analysis	• Individuals decision process should be coordinated with decisions in other functional area • For organizations investing in ODSS, individual decision making improvements should eventually translate into organizational benefits
Decision Support Systems Effectiveness		

Figure 1. IT and DSS Levels of Analysis

Hackathorn and Keen (1981) recognized that although DSS originated to support individual decision making, the challenge was in exploiting DSS in an organizational context. They called attention to the fact that most DSS literature had emphasized individual managerial support and future research needed to examine organization-level impact of DSS. Later, another DSS study also found that most past DSS research had examined the influence of DSS capabilities on user behavior (Eierman, Niederman and Adams 1995). Two decades after Hackathorn and Keen's call for organization level DSS studies, few have taken on the challenge and much of the DSS evaluation research still remains at the individual level (Kohli and Devaraj 2003a).

Several early studies to measure the business value of IT showed mixed (Barua, Kriebel and Mukhopadhyay 1995; Byrd and Marshall 1997; Francalanci and Galal 1998) or negative (Lee and Barua 1999; Loveman 1994) results giving rise to much publicized 'productivity paradox' (Ahituv and Giladi 1993; Roach 1987). Rigorous follow-up studies that laid to rest the productivity paradox argument also revealed that past studies that had been looking for IT payoff at the economy or industry level should have been examining the impacts at the firm-level (Brynjolfsson 1993; Brynjolfsson and Hitt 1995, 1998; Devaraj and Kohli 2000; Hitt and Brynjolfsson 1996; Mooney, Gurbaxani and Kraemer 1996). At the industry level, the IT benefits gained by innovative firms are offset by firms that did not implement IT successfully, thus demonstrating mixed or negative results. While the DSS literature faces the challenge of moving from the micro to macro level, the business value of IT, or IT payoff, literature appears to face challenges to move from the macro level to micro level. As the consensus migrates toward measuring firm-level impacts, there are growing demands that to truly understand how organizations benefit from IT, researchers need to examine IT's role in improving business processes (Chircu and Kauffman 2000; Lillrank, Holopainen and Paavola 2002). After all, they contend, it is the aggregated improvements in business processes that eventually lead to organizational impacts. As illustrated in Figure 1, the IT business value literature calls for measurement toward the firm or the process level. However, in the OS literature, Mohr (1982) suggests that organizational, or firm level, benefits are too elusive to be measured and even when they are measured, they may not be generalizable. Further, he argues that it is unlikely that there can be a theory of organizational effectiveness as the two terms are impertinent to each other (pg. 132) Doubts have been cast that aggregation of several optimized functional areas can result in overall organizational effectiveness (Bregman 1995). Although, each approach has its strengths and weakness, intuitively the operational level measurement provides managers with potentially actionable findings. Process or operational level findings can be actionable because managers have greater control over the processes as opposed to the firm. Of course, process level data can be aggregated into firm level so there is no loss of meaningful information. However, if the data are gathered at firm level, it is difficult, if not impossible, to break them down in to process level. Firm level impacts are also susceptible to distortions due to mutually competing processes or misaligned strategies.

The above discussion of the IT business value and the DSS literature demonstrates the tension in measuring the business value of a DSS that is also a significant organizational IT investment. Thus it is appears that further research is needed to closely examine process level measurement of IT value vis-à-vis that at the organization level. Huber and McDaniel (1986) propose that future conditions are likely to change the organization's traditional workflow to a decision-making paradigm in which organizational structures and processes should be designed such that they facilitate high quality decision-making. ODSS provide an opportunity to further an organization's decision making paradigm and, therefore, render it important to measure their investment. The quality of individual decision making is generally represented by the improvements in the process and the design of decision outcomes (Forgionne and Kohli 1996; Forgionne and Kohli 2000). However, the manifestation of organizational decision making remains scantily explored and few studies have examined ODSS impact at the process level.

	Level	Payoff Objective	Metrics	Past Studies
Macro	Economy	Quantify the impact of IT spending for welfare of the citizens	Overall productivity, GDP	Stiroh, Strassman (1990),
	Organization	Assess how the investment in IT helps the organization become more effective	ROI, Sales/per employee, Market share, customer satisfaction, overall profitability	Hitt and Brynjolfsson (1996), Kohli and Devaraj (2003), Barua and Mukhopadhyay (1991)
	Department/ Process	Examine the role of IT in improving organizational process outcomes	Throughput rate, Accounts receivable days, Days of cash,	Mukhopadhyay (1997); Patsko et al. (1994)
Micro	Individual	Examine the role of IT in improving an individual's decision making process, quality of decisions, and productivity	Number of alternatives, profitability of decision option	Forgionne and Kohli (1996; 2000), Udo, (1992)

Figure 2. Level of Analysis in Decision Support System (DSS) Research

Poole and Van de Ven (1989) suggest that the level of organization is a legitimate research issue and suggest four ways to resolve tension including a multi-level analysis. The method for multi-level analysis begins with a comparative analysis and then

proceeds to clarify the levels of analysis. Figure 2 presents such a framework to examine the levels of measurement in IT business value literature, the metrics involved and past measurement studies.

Research Objective and Setting

Our research in progress will analyze monthly department level data from seven healthcare organizations consisting of expenses, resources consumed, quality, productivity, and profitability measures and the process affected by the decision makers' use of ODSS. Similar analysis will be conducted at the organizational level to compare with the process level outcomes of ODSS use. Following the work of Hitt and Brynjolfsson (1996), we will rely upon the past literature to examine the variety of outcomes measures because IT value can manifest in many ways.

The research setting is a national health system comprising of seven suburban, mid-sized acute care hospitals represented in various geographical regions of the US. With over 4,000 combined beds, 20,000 employees, and annual operating revenue of approximately $1.5 billion, each hospital is an independent legal entity with its own board and financial statements. Data were collected for 36 monthly periods for the outcomes of the use of an ODSS. The ODSS helps decision makers analyze contracts by comparing costs of expected services and expected payments from insurers, and identify areas of cost cutting and operational improvements necessary for financial viability of the hospital.

Analysis, Results and Contribution

The analysis will entail a regression equation to examine the impact of IT investment upon the process level performance. Similarly, another regression equation will measure the impact of IT investment upon the firm i.e. hospital. These two will then be compared to examine if the impact of IT is found to be the same at the process and the firm level. Another alternative is the 2-stage least squares analysis to examine if the variance explained at the process level is the same as the variance at the hospital level. The regression equations will include the common variables to control for the complexity and volume of services in the hospitals. A sample set of equations is as follows:

Department level performance = x1 * IT Expenditure + x2 * Usage + x3 Productivity Statistics + x4 * Dept Expense

Firm level performance = x1 * IT Expenditure + x2 * Usage + x3 * Employees + x4 * Casemix index

IT Expenditure captured expenses booked to the general ledger for IT Labor, IT Capital and IT Support. *Usage* was captured by the number of reports executed, the CPU time consumed by the execution of these reports and the disk input/output activity in the number of records read and processed. Each decision-maker's log-in to the DSS is identified by the hospital as well as the username. As the model or report is executed, an automated DSS utility program records the user's name, report name, date and time, CPU time utilized, elapsed time, and disk input/output activity. *Productivity statistics* are chosen by a functional unit to track its performance such as through units of laboratory tests, number of x-rays, or number of patients registered, while *Departmental Expense* is the actual general ledger expense for the functional department.

The *Casemix index* is a measure of the range of services offered by the hospital. The higher this measure, the more complex the services rendered by the hospital. Revenue and Reimbursement are affected by higher casemix due to higher resource consumption generally expected for such services. Our operationalization of the *Employees* variable was through the number of full-time employees to provide a measure of the labor intensity. The relationship between the number of employees and organizational performance has been of interest to healthcare management researchers and is accounted for in our model. We anticipate that our findings will shed light on the relevance of measuring information technology value at the process level. The findings will provide guidance to business organizations as well as researchers on where to examine IT value. The results will suggest if there are conditions under which the organizational or process level of measurement is preferred. Such findings will provide guidance to the organizations where they are more likely to find value for their IT investment which occasionally appears to get lost in the measurement process.

References

Available upon request.