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A Framework for IT Evaluation Research

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Abstract

"IT evaluation" research is concerned with the impact of information technology in organizations. IT evaluation research requires consideration of various aspects related to the nature of evaluation as well as to information technology. This paper examines these aspects and proposes a framework for classifying research in this area. A preliminary attempt has been made in this paper to categorize research that evaluates the impact of organizational IT. The categorization indicates gaps in research and suggests that different approaches need to be employed to understand the value that is derived from IT.

Introduction

IT (Information Technology) evaluation is defined as "a process that takes place at different points in time or continuously, for searching for and making explicit, quantitatively or qualitatively, all the impacts of an IT project" to an organization (Farbey et al, 1999). Organizations continue to invest considerable resources in IT based systems, while the existence of a relationship between the investments and return on IT continues to be questioned. Researchers and practitioners alike have recognized the problem with information technology investment evaluation; one of the reasons cited is that the benefits realized from IT investment are hard to identify and quantify. Further, in many instances computerization is seen as being obligatory for the well-being of the organization, thus emphasizing justification and avoiding evaluation (Farbey et al, 1999; Powell, 1992). IT evaluation research has taken various approaches to overcome these problems, as is reflected in the various papers published in this area.

This paper examines IT evaluation research and constructs a framework for organizing past research. The paper begins by identifying the different elements of IS evaluation research that might serve as the dimensions for the framework. Next, studies of IT evaluation published during the past twenty years are categorized in accordance with the framework. The paper concludes with a discussion on utility of the framework.

IT Evaluation research

A review of research on evaluation of information technology (IT) reveals varying research approaches and mixed results. The reasons are obvious; the measurement of impact of IT on the organization incorporates various dimensions. For instance, the effects of IT may be measured for the organization itself or for entities within the organization – groups or individuals; the impact may also be measured with an external focus considering the industry, or the society as a whole. The impact also varies depending on the nature and domain or scope of the information system itself. This pluralism of approaches and disagreement in results are not surprising, since the question of IT value for the firm is actually composed of several different issues. Three separate questions have to be considered in researching IT value for the firm; these are the issues of productivity, business performance and consumer value (Hitt & Brynjolfsson, 1996).

Table 1 contains a review of papers that study IT evaluation. All these papers examine the impact of different types of IT on performance at different organizational levels. Although this review is by no means exhaustive, it can be considered a representative sample of research in the area.

The results of the different articles on evaluation research have been mixed. While earlier studies have shown little evidence of IT investments creating value for the firm, recent studies have shown more evidence of positive impact of IT investments (Banker et al, 1990; Barua et al, 1995; Eynon & Ambrose, 1998; Kelley, 1994; Mukhopadhyay et al, 1995; Nault & Dexter, 1995). Still, other studies as Tam (1998) and Mahmood & Mann (1993) show mixed or no results. The causes identified by Brynjolfsson (1993) for lack of evidence of IT impact on productivity – measurement error, lags in realization of benefits, redistribution of IT benefits and misallocation and over-consumption of IT, may explain these diverse results.

Aspects of IT Evaluation Research

Examination of past IT evaluation research in this area reveals various issues (for example, level of analysis, research approach, theory base) that need to be addressed. Issues such as these point to the complexity of this research area. In addition to the studies in Table 1, the review of past research has also identified articles that examine the field of IT evaluation research (Kauffman & Weill, 1989, Smithson & Hirschheim, 1998).

Kauffman & Weill (1989) proposed a framework for research on the effects of technology investment; this framework focuses on the methodology of research on the business value of IT. Kauffman & Weill's framework is based on a review of previous empirical work and has the goal of advancing research on IT evaluation.

Table 1 : Review of IT Evaluation Research

Author	Unit of Analysis	Research model	Results and Comments
Lucas, 1975	Sales Information System use	Use of information system related to performance of individuals	Weak associations between performance and use of the system
Cron and Sobol, 1983	Level of computer usage	Effect of computer utilization on organizational performance	Firms with high computer usage are either very strong or weak performers
Bender, 1986	Information processing expense	Financial impact of IT investment	Appropriate level of IT investment has a positive impact on total expenses
Banker & Kauffman, 1988	Membership in banking (ATM) network	Effect of membership in network on market share	Membership in network important to protect market share
Alpar & Kim, 1990	IT investments	IT investments related to different aspects of bank performance	IT investment resulted in low cost operation
Banker, Kauffman & Morey, 1990	Deployment of point-of-sale IT in business units	Use of system related to operational efficiency	The system helped reduce costs
Weill, 1992	Strategic, Informational and Transactional IT investment	Effect of IT investment on firm performance, moderated by "conversion effectiveness"	Over the six years, heavy transactional IT investment was associated with strong firm performance. No evidence of relationship between strategic and informational IT and performance
Mahmood & Mann, 1993	Firm level IT investment	Effect of IT investment on organizational strategic and economic performance	Total investment related to performance
Kelley,1994	Process-specific IT – programmable automation for machining	Production time per unit of output is a function of product quality and complexity, technology, economies of scale, learning and customization, labor characteristics and industrial relations, and organization of work	Overall, programmable automation estimated to reduce production time by 40%; experience, availability of technology have differential impact on productivity
Barua, Kriebel & Mukhopadhyay, 1995	IT impacts on business unit in manufacturing sector	Effect of IT capital and purchases on capacity utilization, inventory turnover, quality and price	Positive impacts of IT on the business unit's performance
Mukhopadhyay, Kekre & Kalathur, 1995	EDI technology	Literature on inter-organizational systems indicates that electronic communication between trading partners would improve communication because of the superior speed and accuracy of information exchange	Cost savings result from use of EDI
Nault & Dexter, 1995	Commercial fueling system	Effect of IT on price	Customers will pay a price premium for convenience provided by IT
Ryker and Nath, 1995	Use of IT by individuals	Effect of IT on job dimensions – identity, autonomy, etc;	Significant effect of IT on job dimensions
Brynjolfsson, 1996	IT hardware investment	Estimation of consumer surplus from IT investments	IT investments generate 3 times their cost in value for managers
Brynjolfsson & Hitt, 1996	Firm-level investments in IT	Contribution of IS to firm level productivity	Statistically significant contribution of IS to firm output
Eynon & Ambrose, 1998	Firm level investments in IT	Relationship between investment in IT and firm performance can be understood by looking at the interrelationships of system complexity, business quality, and investment to performance	Investment in information systems is positively related to performance
Tam, 1998	Firm level investments in IT	Effect of IT investment on firm performance and stock market return	IT investment not correlated with shareholder return and IT investment not directly related to performance
Bharadwaj et al, 1999	Firm level IT investments	Effect of IT on firm performance and growth potential	IT contributes to firm performance

Three aspects of IT evaluation research form the basis for their framework: the focus of the analysis, the motivation for the analysis, and the measurement and contextual issues in the analysis.

Smithson & Hirschheim (1998) provide an updated version of the framework from Hirschheim and Smithson (1988). Their goal is to provide a way to classify the literature on IT evaluation. This framework has two dimensions; the evaluation approaches and their origin (i.e. reference disciplines) constitute one dimension. The underlying assumptions of different evaluation approaches form the basis for the categorization into three zones: efficiency, effectiveness, and understanding, on the second dimension.

Both Kauffman & Weill (1989) and Smithson & Hirschheim (1998) suggest (the first explicitly and the second implicitly) that the different elements in IT evaluation research can be partitioned into focus, motivation and research approach categories.

Motivation for IT Evaluation Research

Research is an attempt by the researcher to understand and explain something of interest. The research question that is expressed by the researcher reveals the goals of the study. The researcher's worldviews shape the measures as well as the interpretations of that which is studied (Gregory & Jackson, 1992; Mason & Swanson, 1980). The review of IT evaluation research in Table 1 reveals that most studies examine the efficiency or effectiveness of IT. Though used commonly as synonyms, the words "efficiency" and "effectiveness" are associated with different notions of evaluation.

Efficiency is the accuracy and completeness of goals achieved in relation to resources expended and demands that we get maximum output from minimum application of resources Effectiveness is the accuracy and completeness with which specific goals are achieved and demands that the right resources are correctly applied. In the efficiency perspective, the focus is on the operations of the system itself, while in the effectiveness perspective, the focus is on how well the use of the technology serves the needs of the organization. It must be noted that the effectiveness of the system's use (by the users) will affect the efficiency of the system's processes. Further, in assessing effectiveness we consider the usefulness of the products of the system, which raises the question "whom the product is to be useful to". Efficiency evaluation is based on objective or rational assumptions and performance is measured through cost and productivity analysis. IT effectiveness is measured through analysis of areas such as business efficiency cycle time, product quality and customer satisfaction, and evaluation has to include several non-quantifiable goals (Gregory & Jackson, 1992; Smithson & Hirschheim, 1998). Besides these two approaches, Smithson & Hirschheim (1998)

describe a third objective for evaluation: understanding. The purpose of evaluation here is to understand the impact of IT within the particular organizational context. For example, often several conflicting goals of different stakeholders need to be considered to understand the full impact of IT within the organization.

Kauffman & Weill (1989) explain the motivation for the *methods chosen* as the purpose of the study, the methodological approach, and the theory base for the research model. Since the goal of their framework was to identify methodological issues, this description was appropriate. However, since the goal of this paper is to build a framework that spans both methodological and content issues, the motivation for analysis includes the research question, the nature of the research, the specific theory base and/or reference discipline for the research. To avoid confusion, the phrase "nature of the research" has been substituted for the term "methodological approach" used by Kauffman & Weill (1989) to denote whether the research is of exploratory or confirmatory nature.

The Focus of IT Evaluation Research

IT will have impacts at different levels related to the organization; these may be seen as being external or internal to the organization. Industry, customers, and society are seen as external to the organization, while the firm and its constituents would be the target of internal focus (DeLone & McLean, 1993). Farbey et al (1999) have noted that the evaluation of IT may be required at different levels: subproject, project, programme, portfolio, IS strategy, corporate, industry and IT department. Smithson & Hirschheim (1998) offer a more concise listing; they identify five different levels for evaluation: the macro or international level, the sector or industry level, the firm level, the application level and the stakeholder level. Bakos (1987) offers a similar listing: individual, workgroup including many individuals, organization made up of groups, industry, and the economy as a whole.

The scope of the information system under scrutiny is related to the level of analysis (DeLone & McLean, 1993). Farbey et al (1999) state that the complexity of evaluation increases as we move from simple to more complex systems, corresponding to the increase in risk. This variation in risks has been noted also by Clemons (1991), who identified different forms of risks: financial, technical, project, functionality, and systemic risks. Different aspects of the information system may also be under scrutiny - the system itself, the process of use of the system and the impact of the use of the system. As noted by Kauffman & Weill (1989), information system performance is rarely considered explicitly; instead, investments in IT or use of IT are considered as having an impact on firm performance. The scope or nature of the information system may also be

represented in terms of its capabilities or characteristics as integration, flexibility, etc;

Further, the focus of the analysis may be current or future information systems. When we consider future systems, evaluation may be performed to select one of several alternatives and to establish expectation measures or performance metrics for the system. For current systems, the analysis may be carried out at different stages in the life cycle of the system: during the development, implementation, and use and maintenance stages. Brynjolfsson (1993) notes that time lags in the payoffs to IT make analysis of current costs to current benefits misleading, suggesting that data need to be collected at different stages to recognize the benefits from the information system.

Research Approaches in IT Evaluation Research

The objective of the researcher has a significant role in determining the research approach. Evaluation approaches have been classified into two major categories – subjective and objective. These two approaches are at opposite ends of the scale with objective approaches using hard, quantifiable criteria for evaluation (Gregory & Jackson, 1992; Smithson & Hirschheim, 1998). The rational, natural and open systems perspectives on organizations explain a researcher's selection of these approaches. A researcher who subscribes to the rational, goal-oriented system perspective will consider IT as an instrument for achieving specific goals and evaluate IT on these goals using objective criteria like measures of total output, quality and productivity. The emphasis in this perspective is on efficiency. In the natural system view, the evaluation is based on whether IT has satisfied the requirements of the different stakeholders having an interest in the performance of the IT or are affected by the performance of the IT, and thus places emphasis on effectiveness. Since the evaluation is based on the perspectives of different stakeholders, the criteria are subjective in nature. In the open systems view, organizations are viewed as being interdependent with their environments and engaging in system-maintaining as well as system-elaborating activities. A combination of objective and subjective criteria may be utilized to understand the capabilities of the information system in this context, and its contribution to the organization and the constituents of the organization in realizing their potential (Gregory & Jackson, 1992; Scott, 1998). Other process related issues are specification of the research model, measurement of variables, and mode of data analysis (Kauffman & Weill, 1989).

A Framework for IT Evaluation

To understand evaluation and its results it is necessary to identify exactly what is being evaluated and why and for what purpose it is being evaluated. A summary of the different aspects of evaluation as discussed above is given in Table 2.

Table 2. Aspects of IT Evaluation Research

Motivation for IT Evaluation Research: What & When	Purpose: efficiency, effectiveness, understanding
	Nature of research
	Theory base and reference discipline
Focus of IT Evaluation Research: Why	Level of Analysis
	Scope of IT
	Stage in the life-cycle of the IT
	Frequency of evaluation
Research Approaches in IT Evaluation Research: How	Approaches: objective or subjective
	Research model
	Measurement issues
	Data analysis

A framework provides a well-defined, formal "model", which encapsulates our knowledge of the research area and matches up with our real world experience. It structures our understanding of the field, providing for us a guideline to interpret data and ask questions, to do further research. Based on the preceding discussion, the following framework in matrix form is proposed. The main dimensions for the framework are the focus of analysis and the motivation for analysis. While the process of analysis is definitely an important consideration, it is an outcome of the aspects considered under focus and motivation for analysis.

The focus of analysis is represented in the framework by the level of analysis based on the listings by Smithson & Hirschheim (1998) and Bakos (1987). The emphasis that has been placed in previous research in identifying the levels at which analysis takes place makes it obvious that this is a significant aspect of IT evaluation. While the Smithson & Hirschheim listing includes five levels, only four of these levels are considered in this framework. The application level in the Smithson & Hirschheim framework refers to the impact of a particular application. Since the nature or scope of the information system is to be included in the grid of the matrix (indicated by the letter "S"), the application level was not included as a category under unit of analysis. The "individuals" and "workgroup" categories from Bakos replace the "stakeholders" category in the Smithson & Hirschheim listing.

The purpose of the analysis represents the motivation of the analysis and constitutes the other main dimension of the framework; further, the reference discipline, where identifiable, is included in the grid of the matrix and is indicated by the letter "R". Table 3 shows the framework with the reviewed articles placed on the framework.

Table 3: Framework for IT Evaluation Research

Focus → / ↓ Motivation	Macro	Sector	Firm	Groups within firms (Business Units, etc;)	Individual
Efficiency	-Brynjolfsson, 1996 [R: Economics]		-Cron & Sobol, 1983 -Bender, 1986 -Mahmood & Mann, 1993 [S: All IT in firm, R: Management] -Weill, 1992 [S: Strategic, informational and transactional systems, R: Management] -Kelley, 1994 [S: Programmable automation] -Brynjolfsson & Hitt, 1996 [R: Economics] -Eynon & Ambrose, 1997 [R: Technology attributes, management] -Tam, 1998 [R: Economics] -Bharadwaj et al, 1999 [R: Finance]	-Banker, Kauffman & Morey, 1990 [S: Point of sale system, R: ?] -Barua, Kriebel & Mukhopadhyay, 1995 [R: Microeconomics]	
Effectiveness			-Alpar & Kim, 1990 -Mukhopadhyay, Kekre and Kalathur, 1995 [S: EDI, R: Economics] -Nault & Dexter, 1995 [S: Inter-organizational system; R: Economics]	-Banker & Kauffman, 1988 [S: ATM network, R: Microeconomics, Marketing Science] -Alpar & Kim, 1990 [R: Microeconomics]	-Lucas, 1975 [S: Sales Information system; R: Organizational theory] -Ryker & Nath, 1995
Understanding			-Smithson & Hirschheim, 1998 [S: Outsourcing]		

Note: S = scope/type of system; R = reference discipline

As Kauffman and Weill (1989) noted, the theoretical basis behind many studies is unstated; further, the referent theory is often unclear. However, most evaluation research appears to consider IS value as an economic construct. Further, many studies use IT investment to represent IT in the organization. Often expenditure on different types of IT products and services in the organization are combined, making it difficult to identify the nature of the system being studied.

Some Final Comments

The criteria for a research framework are conciseness and completeness, permitting representation of research issues that are mutually exclusive and identification of research areas that need to be explored (Gorla, 1989). To ensure ease of use and understanding, the framework was created such that it did not include too many dimensions or many categories within each dimension. This parsimony may cause a somewhat restrictive order, but by identifying the most relevant aspects of IT evaluation research, a meaningful categorization has been accomplished.

The gaps indicated by the framework may be indicative of the limited number of articles chosen for review. However, the pattern that is revealed shows that the question of IT value has most often been posed with an internal focus. This directs attention to issues that are of immediate significance to the organization. Considering the purpose of analysis, the majority of research has centered on efficiency evaluation. One of the problems in the categorization was that there did not seem to be "one" definition of information technology. In most cases, IT was represented by investments in IT; however, costs for hardware alone to costs for all technology and services were used to represent IT investments.

Smithson and Hirschheim (1998) note that there is no one single evaluation method that is suited for all situations. Farbey et al (1999) has also commented on the need for matching the approach with the system to be evaluated. Research so far seems to have concentrated on data that is made publicly available or is of a quantitative nature. Qualitative research methods might provide a better answer to how organizations actually derive value from IT and suggest better methods of IT evaluation.

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