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ARTIFACT EVALUATION OF ES IMPACT ON ORGANIZATIONAL EFFECTIVENESS

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Abstract

The topic of this paper is issues and problems with Information Systems (IS) evaluation methods in relation to Enterprise Systems (ES). The motivation for this is twofold; first the importance of IS evaluation per se and secondly the importance of the IS in question, namely ES. The purpose is to discuss the applicability of some IS evaluation methods on evaluating ES and to propose an interpretive artifact evaluation approach to ES evaluation based on the competing values model. This is a theoretical approach and the evidence in support of the arguments described here is based on the previously published work of other academics as well as the conceptual work of the authors. The paper presents an alternative approach to evaluation of ES and their possible contribution to organizational effectiveness.

Introduction

Despite the widespread adoption of Enterprise Systems (ES) by business organizations (Joseph and Swanson 1998; Markus and Tanis 1999) ES has been under-researched and under-taught in the information system community. The desired end and the rational has in many cases been improved organizational effectiveness and the attraction in ES lies in that organizations believe there are values for organizations in integrating business processes (Taylor 1999). Studies have indicated improved organizational effectiveness, such as business process improvement, increased productivity, integration among business units, as well as real-time access of data and information. The same studies have also described cases where the implementation has failed and the result has been the opposite effect on organizational effectiveness (Davenport, 1998). So, evaluating ES is an important topic in information systems and the importance of evaluating Information Systems (IS) has been stressed over the years by several researchers and is of critical concern to both practitioners and academics (Bjørn-Andersen and Davis 1988; Farbey et al. 1999; Garrity and Sanders 1998; Remenyi and Sherwood-Smith 1999; Willcocks and Lester 1999). The importance of the topic might be illustrated by the number of evaluation frameworks, methods and methodologies present in literature (e.g. Alter 1999; DeLone and McLean 1992; Farbey et al. 1995; McKeen et al. 2000).

The purpose of this paper is to critically discuss some IS evaluation methods applicability on evaluating ES and propose an interpretive approach. The paper is structured as follows. First, we will discuss some principles about evaluation. . Second, we will discuss some IS evaluation methods and frameworks. Fourth, we will suggest an interpretive approach, i.e. artifact evaluation, as a more fruitful approach to evaluating ES and finally present some hypothesis about the impact of ES on organizational effectiveness.

Principles of Evaluation

IS evaluation is not a simple, straightforward process. (Remenyi and Sherwood-Smith 1999; Kumar 1990). Even if there are some differences of the purpose with the evaluation and how to categorize the evaluation; there are several common factors of all evaluations. In order to perform evaluation, organizations use measurements (Venkatraman and Ramanujam 1986; Willcocks and Lester 1999). Strassman (1985 p. 100) states that: “*You cannot measure what is not defined. You also cannot tell whether you have improved something if you have not measured its performance.*”, i.e. the need of an operational definition. It is important, however, to remember that, “*Figures never are facts!*” (Hoebeke 1990). Measurements are invariably used in complex processes

where both translations and interpretations take place, usually several times in different steps. This, as Hoebcke (1990) points out, makes the concept of relevance a lot more important than objectivity – there has to be a shared meaning of the intentions and their effects by those who play a role in the process of collecting, translating and interpreting the measures, as well as those who act upon decisions based on said measurements. Further, Elliot Jaques (1989) has identified four time strata for which measurements can be relevant, two in what he labels the operational domain and two in the general domain. The stratum in the operational domain span from three months to two years and the stratum in the general domain have time spans from two to ten years.

Is Evaluation Methods and Frameworks

Farbey et al. (1995) propose a model that according to the authors relates specifically to the need for evaluation, which is based on the perception that it is possible to stratify different types of organizational change and connecting it to different IS. It consists of eight rungs, ranging from “mandatory changes” to “business transformation” (See table 1) (Farbey et al. 1995). Their classification is not rigid but still implies that higher levels of change increase the levels of potential benefit, but also increase the uncertainty of outcome. Potential benefits and level of uncertainty are both cumulative, thus systems classified on a certain strata may have all the benefits (and accumulated uncertainty) from any or all of the strata below.

Table 1. The Benefits Evaluation Ladder (Farbey et al. 1995, p. 42)

<i>Rung nr.</i>	<i>Description</i>
8	Business transformation
7	Strategic systems
6	Inter-organizational systems
5	Infrastructure
4	MIS and DSS
3	Direct value added systems
2	Automation
1	Mandatory changes

Farbey et al. (1995) argue that type of application and type of objective (of change) are two of the most influential factors in the choice of evaluation method. A classification of “... *the uses of information systems may therefore be of fundamental importance in selecting suitable evaluation methods*” (Ibid, p. 41). They conclude that for the implementation of systems on the 8:th rung “... *benefits stem from the transformation as a whole. IT provides only one component of what is often a complex series of changes. It is not possible to attribute a portion of the benefits gained to any one factor*” (Ibid, p. 49).

We argue that in Farbey et al.’s taxonomy, ES are on the 8:th rung and that they have the possible benefits and accumulated uncertainty of all the strata below. Therefore, it’s highly unlikely that any two implementations will have identical requirements or consequences, even if they are based on the same generic software packages. While the potential benefits might be articulated, it makes the actual benefits from implementing an ES hard to define, predict, and evaluate.

McKeen et al. (2000) have proposed a synthesized model based on a literature survey, with links to Agency theory and Transaction Cost Economics. They propose that their model “...*can apply to all sorts of projects and organizational forms*” (Ibid, p. 13) and that IT investments can be considered a chain of events and, “*The level of conversion effectiveness (i.e., the mix of internal managerial and external environmental factors) dictates the extent to which each of these variables ultimately transforms into organizational performance*” (Ibid, p. 14). Continuing, McKeen et al. (2000) states that “*With the focus at the enterprise level, it should be possible to capture the effects of the total IT investment on the organization’s performance provided that the performance measure is related to the usage of the technology*” (Ibid, p.15) and “*IT investment should be accurately captured at the enterprise level by examining all IT expenditures. Furthermore, looking at changes in these figures over time and relating them to other variables in the model should be more revealing than an examination of their absolute levels*” (Ibid, p. 17). While it is reasonably easy to collect the IT related costs, the interdependence between an ES and the organization (Bancroft et al. 1998; Farbey et al. 1995; Van Der Zee and De Jong 1999) makes it hard to calculate the total cost of implementing an ES, as well as relating performance to usage. The delimitation of level of analysis to a whole enterprise is based on the expected probabilities to get relevant measurements of cost and performance combined with a holistic perspective on the decision process. This is especially true in the case of ES, as they are implemented to support functions on all levels of an enterprise (Davenport 1998; 2000).

In Steven Alter (1999) IS theory he proposes a distinction between information systems and what he refers to as the “work system(s)” it serves. Alter (1999) defines a work system as “...a system in which human participants and /or machines perform a business process using information, technology and other resources to produce products and/or services for internal and external customers”. Alter suggests that using work system as focal point for understanding the operation and significance of specific information systems has a higher degree of usefulness than looking at, say, the information technology employed or focusing on the organizational level. This is illustrated in figure 1.

Alter (1999) summarizes his IS theory in 14 statements, dealing with the relationships between work system, information, participants, processes, impact, success etc. In his first statement, he argues, “work systems can be subdivided into a set of smaller work systems” and continuing “The choice of how to define the work system under consideration depends on the problem and the analyst”. Further, in his 9:th statement, he concludes that “In most cases of the cases when an information system improvement has a major impact, those improvements are accompanied by other, equally essential improvements elsewhere in the work system”.

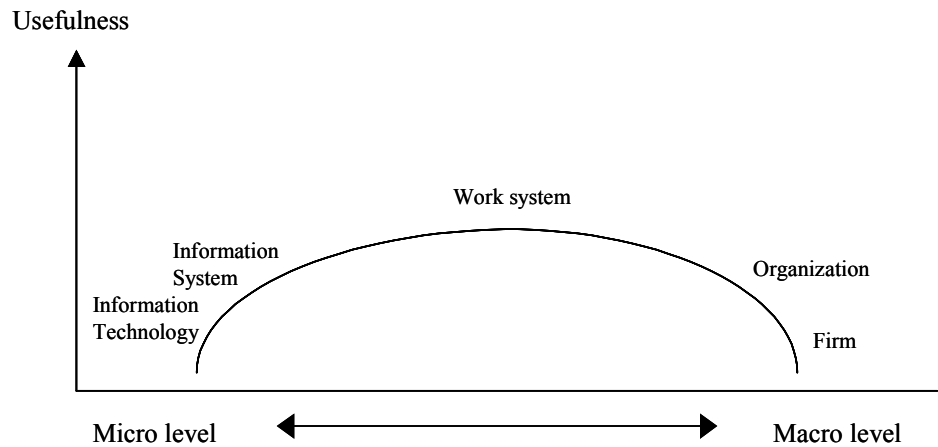


Figure 1. Degree of Usefulness of Focal Points (Alter 1999)

Artifact Evaluation

The interpretive approach we suggest belongs to research stressing artifact utility, which can broadly be divided into artifacts building and artifacts evaluation approaches (Järvinen 1999; 2000). Although critical, this type of research is not well represented in IS research (Järvinen 1999; 2000; March and Smith, 1995; Lee, 2000). We chose Robert Quinn and associates' competing values model (CVM) as a framework to evaluate ES. There were optional evaluation approaches, e.g. usability frameworks, but this and other evaluation frameworks are aimed at evaluating actual use. So, the two main reasons for using the CVM where: First, it is a well-established framework and model and it has been developed and empirically tested in organizational, management, and IS research over a number of years. Second, it is related to a critical construct: individual and organizational effectiveness. In brief CVM is based on the finding that most measures of effectiveness reflect one of four organizational models: human relations model (HR), open systems model (OS), internal process model (IP), and rational goal model (RG) (Quinn and Rohrbaugh 1981; 1983), with respect to three sets of underlying competing value dimensions: The first value dimension is focus, which is concerned with issues that are internal or external to the organization. Structure is the second value dimension, and is concerned with stability and flexibility in the dominant organizational structure. The last value dimension concerns ends versus means in organizational goals.

In descriptive literature on ES benefits and ES capabilities we found five broad categories of benefits related to ES and to the impact of ES, excluding technical issues. First, they support organizations by integrating information flows and make the information available to the whole organization (Davenport 1998). Second, ES integrates different business activities, functions, processes, tasks, and workflows as well as integrates secondary activities with primary activities, to use Porters terminology, (e.g. inventory management) (Taylor 1999). Third, ES serve as a common data repository, i.e. master data, for organizations (Scheer 1998). Fourth, they specify how organizations should conduct their business based on a best business practice reference model (Kumar and Hillegersberg 2000). The last category is derived from the ES capabilities delivered by the system per se, e.g. controlling, financial accounting, investment management, human resource management, materials management, plant maintenance, production planning and control, project planning system, sales and distribution, quality management (Keller and Teufel 1998). The outcome of the classification and evaluation is depicted in figure 2. Note that due to space constraints, this list is simplified, but it still shows the distribution between the areas of focus.

HR Capabilities: Human resource management;	Flexible Means: cohesion; morale Ends: human resource development	Structure Capabilities: None	OS Means: innovation; adaptation Ends: organizational growth
Internal focus Capabilities: Controlling; Investment controlling; Materials management; Production planning and control; Project system; Plant maintenance; Master data; Best practice Integration of information flows; Integration of business processes IP	Means: information management; communication Ends: control	Capabilities: Financial accounting; Sales and distribution; Quality management; Materials management (procurement)	External focus Means: planning; goal setting Ends: productivity
	Stable	Structure	RG

Figure 2. Degree of Usefulness of Focal Points (Alter 1999)

The actual artifact evaluation of ES benefits and capabilities was made in a four-step process. First we listed the ES capabilities and documented ES benefits we could find after a review of literature and material on ES. In the second step the two researchers independent of each other categorized ES capabilities and benefits along the value dimensions in CVM – internal versus external and stable versus flexible. The third step was to map each ES capability into CVM with regard to the value dimensions. In the final step the classification and evaluation outcomes were compared. Where non-agreement existed, the two researchers evaluated again and a final classification and evaluation decision was made.

Most of the ES benefits and capabilities mapped into the internal process (IP) model and the rational goal (RG) model, with an emphasis on IP. Accordingly, ES support IP and RG associated organizational goals. Hence, ES primarily support organizational effectiveness criteria related to efficiency and productivity, and means such as coordination and planning. The strong support of IP is natural since one primary benefit with ES is master data, which refers to the work of creating repository for datum and makes it possible to communicate information through an organization; this is what makes information integration possible. There are also many capabilities focused on internally oriented tasks, which also gives strong support for IP. However the lack of support of human resource and open system was a surprise. The conclusion of the artifact evaluation or mapping between ES benefits and capabilities and CVM show the existence of a in part shared implicit framework as CVM, and ES include the same organizational effectiveness criteria and can be sorted along the value dimensions.

Discussion

It would be tempting to suggest that ES is less good because there seems to exist an unbalanced support of organizational effectiveness. Such a suggestion is based on that organizations have to attain different goals simultaneously and the goal attainment has to be well-balanced (e.g. Campbell 1977). But, such a suggestion misses an important aspect: the context of where the ES is to be used. Studies within the CVM framework suggest that all value dimensions are not equally important and critical. There are changes in the importance of the value dimensions in relation to hierarchical level and what state a firm is in. Quinn and Cameron (1983) found in relation to the CVM framework four different states a firm can be in, namely: 1) entrepreneurial, 2) collectivity, 3) formalization and control, and 4) elaboration of structure state. Later research found linkage between CVM and four types of organizational culture, 1) clan culture, 2) adhocracy culture, 3) hierarchical culture, and 4) market culture (Cameron and Quinn 1999). Further, an ES is seldom the only IS used – of course, other IS also having capabilities. Based on these finding and the artifact evaluation it is possible to hypothesize the impact of ES on organizations.

The first and general hypothesis is drawn form this work and a common contingency perspective on organization

Hypothesis 1. It should be possible to identify organizations and situations when it is more or less favorable to implement ES.

The next hypothesis is based on the conclusion that ES supports some value dimensions better than others. As a result of the concentration of identified capabilities, an ES will give more support to effectiveness criteria that are oriented towards stable structures and emphasizes on the internal aspects of organizations, e.g. control.

Hypothesis 2. It will be more favorable to implement ES for organizations in formalization and control state as well as in elaboration state (Quinn and Rohrbaugh 1983).

Hypothesis 3. Change efforts directed towards increasing flexibility and adaptability will, in consequence of the effects of H2, be in counteraction with the implementation of an ES.

An organization in need of capabilities that support flexibility and adaptability should not implement the ES in question unless they at the same time take other measures that support their needs.

Conclusions

If the true purpose of evaluation is assessing the worth of a system and its impact on the organization and beyond, as Farbey et al. (1995) suggests, there appears to be little value in specific tools or techniques for assessing ES impact on organizational effectiveness. Whether we view ES as one or more work system(s) in line with Alters (1999) reasoning, the impact of ES implementation is a combination of organizational changes, new business processes and IS that appears over time and depends on the usage within not just a part of an organization, but the organization as a whole.

We suggest therefore that the evaluation of ES is highly context dependent and thus measurements of impact on organizations from large IS (such as ES) on organizational effectiveness is interchangeable with measurements of general improvements on organizational effectiveness. Further, for such measurements to be relevant they have to be performed over a long period of time and the measuring would have to be initiated before the implementation is started (Hoebeke 1990). Returning to the quote from Strassmann (1985), we argue that we need to measure effectiveness impact from ES implementations with the same measurements that are used on a specific organization prior to the implementation, and that any changes recorded are attributable to a combination of IS implementation, organizational changes and changes in method of measurement. Thus, measuring or quantifying isolated impact from ES implementation is close to impossible.

At best, we can predict the impact and compare the measurements from *ex-ante* and *ex-post* implementation. This paper presents an evaluation of ES benefits and capabilities from an accepted framework of organizational effectiveness, which can be used to predict the impact on organizational effectiveness. The purpose of the evaluation is to understand how ES might affect organizational effectiveness and the interdependency between organizational effectiveness and ES. The evaluation can be used as a tool for supporting implementation by enhancing or enabling a better communication between designers and users. This is achieved by using the evaluation for discussing organizational requirements of ES and related improvements on organizational effectiveness. The focus is on organizational requirements, motivated by organizational effectiveness.

Important delimitation of the approach is that the following aspects are not taken into account in the evaluation of the current ES: First the value of a benefit or a capability in context, some benefits or capabilities are more important than others. Secondly the impact of the environment and technology of the organization, some benefits and capabilities are more important than other dependent on the environment and technology of that organization. Third the number of user of a capability in an organization, its likely to assume that some capabilities will have several users. These are all contextually dependent and would have to be taken into account for practical use.

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