An Exploration of the Role of Systems Analysis for Ex Ante Business Value Evaluations of Information Systems

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ABSTRACT
Early work on the evaluation of the business impact of information technology (IT) focused on linking investments in IT to productivity. Recently, the trend has shifted to viewing IT within its specific organizational context, in order to better evaluate its impact. In this research in progress, we take the next step along this trend by proposing a framework that examines the business value of an information system (IS) within its context. Our framework explores the insights that systems analysis can provide in analyzing the costs and the several types of benefits that can potentially be due to an IS. This work describes the motivation for the framework, and the propositions that link systems analysis to business analysis. The complete project will involve multiple case studies in real world organizations to test the framework.

Keywords
IT evaluation, business value, costs, benefits, systems analysis.

INTRODUCTION
The business value of information technology (IT) has been a subject of much interest for several decades. Early IT investments were often justified by their perceived abilities to increase productivity. However, for many years, researchers were unable to pinpoint the effect that IT had on productivity, at either the firm, industry or national levels (Dening et al., 2003, Solow, 1987, Strassmann, 1997, Triplett, 1999). Several empirical studies in the late 1980-s and 1990-s found no correlation between IT and profitability, and a number of explanations have been proposed to explain this “productivity paradox” (Bakos, 1998, Brynjolfsson, 1993, David, 1990). These explanations can be divided into two broad categories: a) the inability of the firm or organizational unit to maximize the potential of the IT because of misalignment with business processes or the organizational structure, and b) the difficulty of developing accurate measures to determine the benefits of the IT.

The resource based view of IT (Clemons and Row, 1991) was utilized in several studies that linked the sustainable value of an IT to its integration with business strategies, organizational design and organizational competencies (Barua and Mukhopadhyay, 2000, Kettinger et al., 1994, Wheeler, 2002). (Brynjolfsson, 1993) observed that there may be a lag between the IT installation and the benefits accrued by the IT. Recent studies have shifted focus from cross sectional analyses to longitudinal analyses that accommodate the assimilation of the IT as it diffuses across the business processes of the organization (Fichman and Kemerer, 1997). (Chatterjee et al., 2001) noted that strategic benefits of IT are realized when it enhances business processes and transforms business operations. (Agarwal and Sambamurthy, 2002) investigated firms that integrated IT with their key processes, knowledge and their relationships, thereby accruing benefits in several areas such as manufacturing, purchasing and customer relationship management. Several recent studies that re-examined the productivity paradox also found evidence of the positive impact of IT on firm valuation and performance (Bhardwaj et al., 1999, Brynjolfsson and Hitt, 1996, Brynjolfsson et al., 2002).

However, in the well-known article by (Carr, 2003), IT was argued to have become a commodity, without the ability to provide a strategic advantage. Several rejoinders to the article noted that it was not about the IT but how it was used that resulted in the competitive advantage. Recent work by (Alter, 2005) views IT as a work system, where the IT itself contributes to a system of business processes that bring about the increase in business value to the organization. A comprehensive study by (Anderson et al., 2004) also finds evidence of the strategic impact of IT across industries and firm sizes, when the accommodations are made for the assimilation of the IT with suitable time lags.
The review of literature above makes it clear that there is a growing recognition that it is the interaction of the IT with its context that results in the benefits provided by the IT. Intuitively, it is possible for two organizations in the same industry to invest in the same information system (IS), and for one organization to derive more value than the other. In other words, the focus in IT business value evaluation research is shifting from treating all IT investments in a study similarly to unraveling the interactions between individual IT installations and their contexts. In this work, we take the next step along this trend, by proposing a framework that can measure the business value of IT for individual ISs within their own contexts, consisting of end users and the organization.

Systems analysis (SA) has been traditionally used to understand and document the data and process requirements of end-users prior to the design and construction of an IS. As such, SA can potentially a) provide detailed before and after data elements and process flows (Chen, 1976, deMarco, 1978), and b) allow end-users to get a better perspective of the IS, prior to it being built (Barki and Hartwick, 1994). Our framework explores the insights that systems analysis can provide in determining, ex ante, the business value of an individual IS within its own context. Next, we present the initial development of the framework.

**A FRAMEWORK TO INCORPORATE SA INTO EX ANTE IS BUSINESS VALUE EVALUATION**

Much of the work described in section 1 investigates the benefits of IT ex post. There are several benefits, however, to being able to evaluate the business value of an IS, ex ante. These include the capability to compare different competing IS projects before funding them (Irani and Love, 2002), provision of a benchmarking process that can track the progress of the project and provide early warning signs of failure (Ginzberg and Zmud, 1988), and the justification of investment requests by management (Dugdale and Jones, 1995).

While ex ante IS valuation is desirable, it presents unique difficulties because several benefits accrued by an IS are intangible and non-financial (Farbey et al., 1994, Irani et al., 1997). (Bannister and Remenyi, 2000) report on the increasing discomfort of management towards traditional investment appraisal methods, and a trend towards non-formal “gut feel” methods for evaluating an IS ex ante. It has also long been recognized that, unlike traditional capital expenditures, IS projects are significantly different from each other, so that no one method of investment evaluation will work across all IS projects (Farbey et al., 1994, Irani et al., 1997).

Apart from consisting of significant intangible benefits, the benefits of an IS also occur at different levels in the organization. (Demmel and Askin, 1992) classified benefits along three categories: strategic, tactical and pecuniary. (Peter, 1994) suggested that benefits of the IS can be usually classified as either enhancing productivity, expanding the business or minimizing risk. According to (Sambamurthy and Zmud, 1999), IS spending can be used to change IT infrastructure, maintain existing infrastructure or improve specific business processes. (Chatterjee et al., 2001) polled a panel of IT experts and derived three descriptive labels: “automate” (automate operational level processes), “informate” (affect decision making at the tactical and strategic level) and “transform” (the impact of the IS actually alters the structure of the firm or the industry). The same IS (for example an enterprise wide system) can have an operational impact, where certain low level processes are automated and data redundancies removed, a tactical impact, where more timely access to better information assists line managers in medium term decision making, and a strategic impact where data mining and analysis of the operational level data leads to the development of new marketing or product development strategies.

Based on the above discussion, a framework for ex ante IS evaluation should incorporate the following categories of benefits: a) quantifiable as well as non-quantifiable benefits, b) benefits at different levels of end-users, and c) risk amelioration due to, for example enhanced security or infrastructure obsolescence. Figure 1 displays the list of benefit categories that an IS can potentially impact, along with possible measures for each category.

The quantifiable benefits consist of increased revenue or market share which could serve as inputs to traditional accounting analyses such as economic value added (EVA) (Conrath and Sharma, 1993) or net present value (NPV) (Dugdale, 1991). The non-quantifiable benefits include enhanced customer satisfaction and employee capabilities, which can be evaluated using a balanced scorecard (BSC) approach (Kaplan and Norton, 1992). The non-financial measures incorporated into a balanced scorecard are usually customer satisfaction and employee learning and growth (Kaplan and Norton, 1996). Current reports suggest that approximately 50 percent of all Fortune 1000 companies and 40 percent of European companies have processes in place that use some version of the BSC (Krumwiede et al., 2004). Operational level benefits will manifest as increased efficiency and efficacy of low level business processes. At the tactical and strategic levels, the IS can provide quicker access to information and/or access to better information. Finally, three separate facets of potential risk amelioration that can be provided by the IS are shown in figure 1. Next, we describe the role that SA can play in helping evaluate each of these dimensions.
For the purpose of this work, we assume that SA will result in: a) a data model schema of the end user domain down to the attribute level using a popular notation such as the entity relationship (ER) (Chen, 1976) notation, b) an activity or process model schema of the domain, decomposed down to the “primitive activity” level (Gane and Sarson, 1982), and c) a documentation of which role in the organization will perform each activity. Further, we assume that the process of conducting SA will involve significant end-user involvement at all levels, and provide the end-users with a clearer picture of the proposed IS than they would have had without the SA. Both these assumptions reflect a reasonably detailed SA process. Given these assumptions we list the following propositions:

P1: SA will allow for better estimations of quantifiable benefits, and will facilitate the usage of a quantitative analysis such as EVA.

P2: SA will allow end-users to better estimate the non-quantifiable benefits associated with the IS, such as customer satisfaction and employee education and capability enhancement.

P3: SA will allow for more accurate estimation of changes in operational efficiency and effectiveness

P4: SA will allow for better estimation of the improvements in speed of information access and quality, at the tactical and strategic levels.

P5: SA will allow better estimation of the degree of risk amelioration provided by the IS.

Propositions P1-P5 describe the impact of SA on the benefits of the IS. When conducting a business analysis, it is important to also correctly estimate the costs of the proposed IS. IS cost estimation is a more developed area of research (Boehm, 1981, Mukhopadhyay and Kekre, 1992) and often the costs are provided by the vendor. However, the history of IS projects is replete with time and cost overruns (Genuchten, 1991, Kraut and Streeter, 1995). Further, IS vendors may employ different mark-ups, which are hidden from the organization. Again, we propose that SA will provide a clearer picture of the actual proposed system, and will allow for more realistic cost estimations:

P6: SA will provide insights that will lead to a more realistic cost estimation of the IS.

Figure 1 A Summary of the Potential Benefits Provided by an IS.
The propositional framework developed above describes how SA will impact each benefit category, and contribute overall to the ex ante evaluation of the business value of an IS, within its specific context. Next we describe how we will test this framework.

RESEARCH METHODOLOGY

In order to test the framework developed in section 2, we plan to use a multiple case study method. Two case studies have already been conducted in two diverse organizations: a) the sales proposal system for a small manufacturing enterprise specializing in industrial equipment and b) a wireless system for building and neighborhood inspectors working for the public works department of a medium sized city in the Southwestern USA. At present we are collecting and analyzing the data to see which of the propositions were supported. The results of the study will be discussed at the AMCIS conference.

To offer a flavor of how we utilized SA, a brief example of evaluating the costs of the sales proposal system is described next. First, we constructed the data and process diagrams for the IS over several days of group meetings. A summarized data model, with attribute details omitted for simplicity, is shown in figure 2.

The process diagrams (omitted here for reasons of space) specified activities and linked them to the data. The diagrams listed 16 primitive level activities, that represented all interaction with the proposed IS. The roles that would perform each activity were also listed as part of the process model. Examples of activities included “accept input parameter values from the customer”, “prepare proposals” and “manage product_types”.

We used the results of the SA to create a code plan for the IS. This was then used to create a cost basis for building the IS. The summary of the costs is shown in table 1. The SA was useful for estimating the cost basis, because it gave a clear understanding of the extent of application level coding that would be required to re-create the catalyst.
Table 1. Summary of Cost Basis for the IS

<table>
<thead>
<tr>
<th>Conversion Costs</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design/coding (23 tables/10 screens)</td>
<td>$52,000</td>
</tr>
<tr>
<td>500 hrs @ $80 (outsource) + 200 hrs @ $60 (Jack S)</td>
<td></td>
</tr>
<tr>
<td>Project management/testing/documentation</td>
<td>$25,000</td>
</tr>
<tr>
<td>200 hrs @ $125</td>
<td></td>
</tr>
<tr>
<td>Data migration</td>
<td>$8,000</td>
</tr>
<tr>
<td>100 hrs @ $80</td>
<td></td>
</tr>
<tr>
<td>Staff training</td>
<td>$6,850</td>
</tr>
<tr>
<td>1 person day x 10 persons = 80 hrs @$70</td>
<td></td>
</tr>
<tr>
<td>1 seminar day for outsource = 10 hrs @$125</td>
<td></td>
</tr>
<tr>
<td>New server hardware and software, etc.</td>
<td>$10,000</td>
</tr>
<tr>
<td>Total one time conversion costs</td>
<td>$101,850</td>
</tr>
</tbody>
</table>

Once the cost basis for the new IS had been computed, we next estimated the annual cost changes with the new IS in place. According to the management at EMISSIONSTECH, the SA was instrumental in creating this estimation for the following reasons. First, the process analysis indicated that the sales call process would change in that the geographical reach would be greater since potential clients could access the website from anywhere, fill in their own requirements, and then have a sales person or sales partner contact them with the relevant information. When presented with the detailed analysis of the new process, management estimated that sales would go up by about 5% because of the new IS. The increased sales commission that resulted from this increased revenue is included as a cost in table 2. Second, the SA provided a detailed estimation of the size of application level code that would need to be maintained, thereby allowing for a better estimate of the maintenance costs, shown in table 2 as “annual code changes”.

Table 2. Annual Cost Changes By Operating the New IS

<table>
<thead>
<tr>
<th>Annual Cost Changes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
</tr>
<tr>
<td>Spreadsheet maintenance/updating</td>
<td>$24,000 (a)</td>
</tr>
<tr>
<td>Sales persons time on the spreadsheet</td>
<td>$22,000 (c)</td>
</tr>
<tr>
<td>Sales Assistant time on the spreadsheet</td>
<td>$35,000 (e)</td>
</tr>
<tr>
<td>MIS and outsource time for server</td>
<td>$54,375 (g)</td>
</tr>
<tr>
<td>hardware and software upkeep</td>
<td></td>
</tr>
<tr>
<td>Increase in rep commissions due to increased sales</td>
<td>$18,900 (i)</td>
</tr>
<tr>
<td>(new)</td>
<td></td>
</tr>
<tr>
<td>Increase in annual ISP service (new)</td>
<td>$3,000 (j)</td>
</tr>
<tr>
<td>Annual code changes (new)</td>
<td>$5,000 (k)</td>
</tr>
<tr>
<td>Projected Annual Increase in Costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$44,025</td>
</tr>
</tbody>
</table>

(a) 400 hrs @ $60 = $24,000 (Jack S, development time excluded)
(b) 200 hrs @ $60 = $12,000 (Jack S) + 400 hrs @ $35 = $14,000 (data entry clerk)
(c) 400 hrs @ $55 = $22,000
(d) 500 hrs @ $55 = $27,500 – more proposals, sizing, etc.
(e) 1000 hrs @ $35 = $35,000
(f) 1100 hrs @ $35 = $38,500 – more proposals, sizing, etc.
(g) 1125 hrs @ $40 = $45,000 (Debbie) + 75 hrs @ $125 = $9375 (outsource)
(h) 1200 hrs @ $40 = $48,000 (Debbie) + 100 hrs @ $125 = $12,500 (outsource)
(i) 35% of $360,000 increase in sales times 15% commission rate
(j) estimated annual cost of DSL/T1 service for separate Cenatalyzer server
(k) 40 hrs @ $125 = $5,000

F = fixed cost; S = semi variable cost; V = variable cost
POTENTIAL CONTRIBUTIONS AND CONCLUSION

In this research in progress, we motivated and proposed a framework that links the effects of SA on the business evaluation of an IS. Our completed work will have both theoretical and practical implications. On the theoretical side, we take the growing trend in IT evaluation research that considers IT in its specific context, to the next step of considering each IS individually within its context. Our propositional framework will serve as a starting point for developing a theory of how SA can impact business evaluation of IS. From the practical standpoint, our work and the case study descriptions will serve as blueprints for conducting such analysis in other organizations interested in ex ante evaluation of IS projects.

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REFERENCES.


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\(^1\) Names have been changed to protect the anonymity of the organizations.