COMBINING SOFT SYSTEMS METHODOLOGY (SSM) TECHNIQUES AND DATA ENVELOPMENT ANALYSIS IN AN EXPLORATORY ANALYSIS OF THE USE OF TECHNOLOGY CONSULTANTS FOR IS IMPLEMENTATION

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ABSTRACT
The use of technology consultants to assist in the implementation of complex information technology (IT) innovations has been the trend in the past several years. For some complex integrated software solutions, the consultants have become the largest cost component. This study examines the relative efficiency (success) of technology consultants in IT innovation implementation. Thirty-six firms in North America are investigated using Soft Systems Methodology and Data Envelopment Analysis to explore the impact of selected propositions on information systems (IS) implementations. The results show that three of the five propositions related to the use of technology consultants were supported. Based on the findings of this study, the manuscript provides some practical guidelines, which can be used by management for decision-making to control costs within the organization.

Keywords: soft systems methodology (SSM), data envelopment analysis (DEA), technology consultants, and information systems (IS) implementations.

1. INTRODUCTION

As companies rely more and more on information technology (IT) to conduct business, IT development and innovation costs have exploded (Antonucci, 1998). Strategist Michael Porter (1995) noted that because technology is constantly changing, global competitiveness requires the ability to innovate rapidly. Companies that are the most competitive are those that employ the most technology in their methods (Porter, 1995). Innovation is a subject that has been widely studied across a broad spectrum of disciplines including social science, marketing, engineering and management (Van de Ven 1986). While the literature on innovations and their adoption by organizations is extensive (Rogers 1983), relatively few studies focus on high-technology systems innovations whose adoption necessitates organization-wide changes.

Given the speed with which emerging information systems are enabling the transformation of business organizations and the ways in which they operate, more research is needed to understand the practices that impact the success or failure of these technologies. At the heart of innovation is change, and change brings with it, uncertainty. One approach to reduce uncertainty in the implementation of planned organizational change such as a technical innovation involves the use of consultants.

Previous practitioner literature addressing consultants has identified several reasons for industry growth (Leinfus 1992; Seitel 1989), but little is known about the contribution of consultants to the ultimate success of technological innovation implementation. Assessing the effectiveness of consulting engagements has been addressed in the consulting practitioner literature (Covin and Fisher 1991), but this subject was studied from the perspective of the consulting firm interested in boosting its own revenues. Measuring the productivity of a consultant from the client organization's perspective has not been a focal topic in the literature (Saxton 1995). Little research exists on the factors that contribute to consultants' relative efficiency in implementing technological innovations.

Using empirical data, this article explores how well organizations implement a technological innovation using consultants, by measuring the relative efficiency of the implementation process. Then, this research investigates whether or not efficiency results differ according to several factors, which are identified through analysis using Soft Systems Methodology (SSM), and are presented in the form of propositions. This study was undertaken to provide managers considering the adoption of high-technology innovations with insight into ways to improve their efficiency (success) in implementing technological innovations utilizing consultants.

The organization of this article is as follows. First, the literature dealing with technology consultants and measuring efficiency of implementation is reviewed. Then, a Soft Systems Methodology (SSM) analysis of organizations implementing an instance of a high-technology innovation is presented. Next, the data analysis techniques are described and the results are summarized, and then the results are used to identify the supported propositions. Finally, specific recommendations are made for managers considering the adoption of complex high-technology innovations.

2. THEORY AND PROPOSITIONS

2.1 Role of Technology Consultants in Innovation Implementation

Ultimately, if the innovation is to succeed, the product/service must serve the customer's needs. This attention to meeting the customer's needs has important implications regarding implementation of the innovation. It is at the commencement of the implementation activities where the customer becomes the user. Fullan and Pomfret (1977) describe the goal of implementation as "Maximization of the degree in which the actual use of an innovation corresponds with its intended use."

Consultants can be very useful at this organization-innovation interface, assisting the adopting firm in making the transition to facilitating the actual use of the technology by specific individuals. Greiner and Metzger (1983) present six reasons that clients have identified for using consultants:

1) To provide independence and unbiased judgment.
2) To present new ideas and a fresh approach.
3) To assist in diagnosing problems and evaluating solutions.
4) To perform tasks requiring technical skills infrequently needed.
5) To supplement the skillsets of present staff and/or management.
6) To implement systems and train employees.

This study will address the important role of consultants as facilitators for systems implementation, which would encompass items 4), 5) and 6) above. Consultants are particularly valuable in the case of technological innovations because of the multifaceted issues in implementation. As pointed out by Van de Ven (1986), the likely success of technological systems innovations involves organizational acceptance of the hardware and software features, as well as adaptations to administration and behavior within the organization.

Since there is so little prior work related to the role of technology consultants in innovation implementation, this study is by necessity exploratory in nature. Due to the exploratory context of this study, a multi-methodology design was employed. Since middle and senior management from the IT function in the participating companies were involved, an especially flexible methodology was desired as the 'front-end' analysis approach. Soft Systems Methodology (SSM) has been used successfully in a number of analytical studies involving pairs of methods (Munro and Mingers 2000), and has been used extensively in information systems development where harder, more quantitative techniques were used in the evaluation phase of the project (Stowell, 1995). Soft Systems Methodology (Checkland 1981; Checkland and Scholes 1990) is based on interpretive philosophy. First, SSM analysis was utilized to work with the pilot group of adopter organizations to investigate the situation through interviews and meetings, thereby formulating a rich picture of innovation implementation. These interviews and meetings, held with this pilot group of senior managers and the principal author was employed to identify the technical, political and cultural issues considered in the implementation process, as well as the role of technology consultants in this process. These participants developed root definitions from the rich pictures by documenting the relevant systems and giving them definition through the CATWOE analysis, the results of which is presented in Figure 1.

Soft Systems Methodology (SSM) Analysis
Primary Task Root Definition:
A system, affected by a set of external influences, which functions within an IT strategy based on its capabilities and costs, and delivers services to implement the IT innovation. These services are defined in contracts with the vendors, subject to the norms and policies of the implementing organization, and the software projects, initially chosen to be developed with the innovation, should contribute to the organization's strategic mission.
The CATWOE elements for this root definition are as follows:
C personnel in the systems development function
A technology consultants
T need for improvement in systems development services → need for improvement met
W systems development services that contain IT innovation will better deliver these services
O management of each adopter organization
E structures and norms of each adopter organization; availability of information regarding user needs in each adopter organization

Figure 1. CATWOE Analysis

The participants then built a conceptual model of the activity system which yields the transformation defined in the root definition, and is more fully described in the activity model shown in Figure 2.

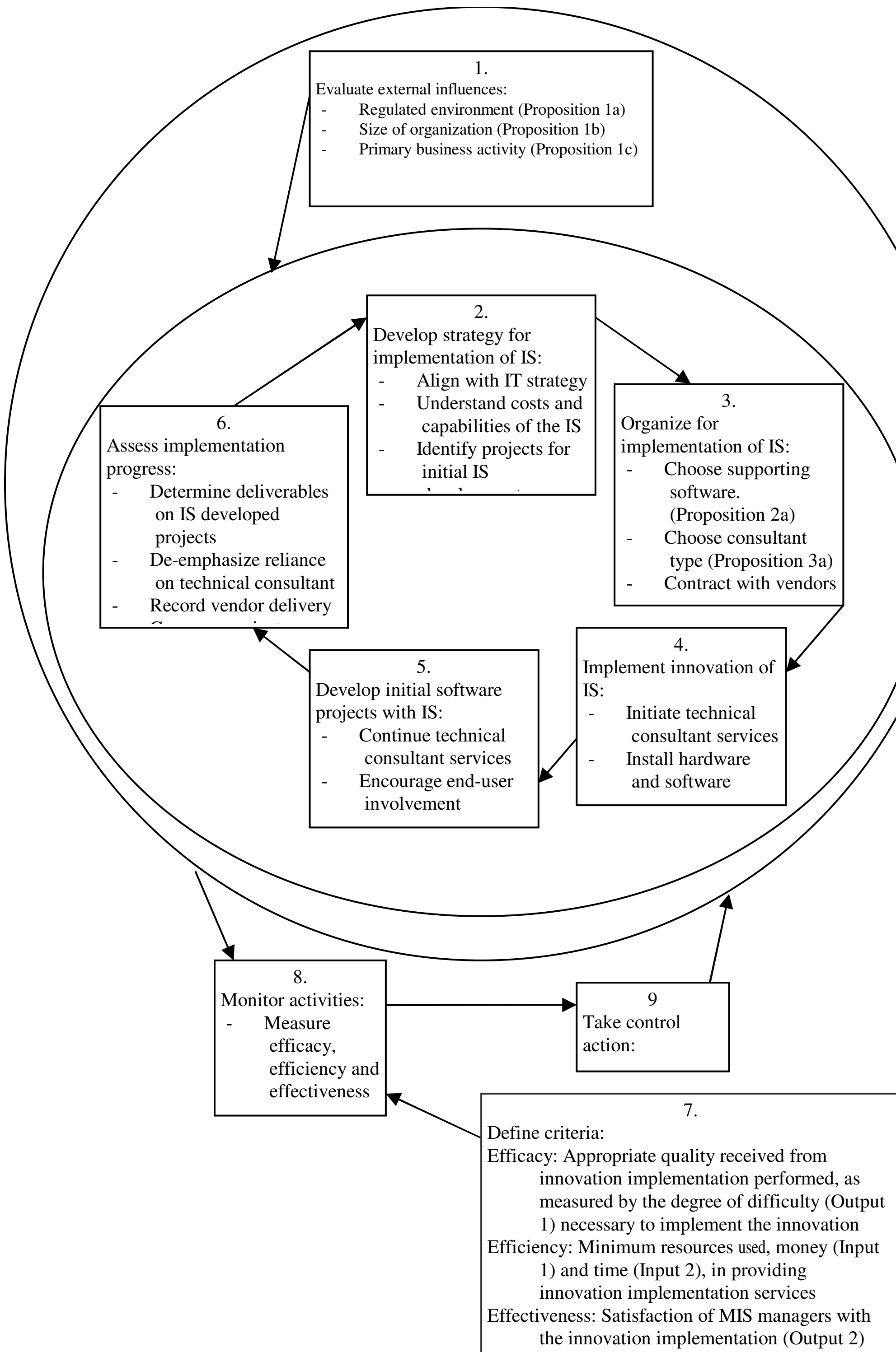

Figure 2. Activity Model of IS Implementation

The results of this SSM analysis phase were used to structure further exploration of the consultant's role in innovation implementation by identifying the following:

- Measurement and control activities of the transformation process (Step 7 in Figure 2) which are utilized in Data Envelopment Analysis (DEA) to determine relative efficiency measures of the adoptive organizations, and
- External and internal factors involved in the adoption process (Steps 1 and 3 in Figure 2) which may affect the efficiency of the implementation itself, and these possible relationships are explored using statistical analysis.

In this study, the authors apply a research framework utilizing two methodologies: Soft Systems Methodology (SSM) and Data Envelopment Analysis (DEA). SSM was utilized in order to address the qualitative, people-centered issues that were present in these real world examples of using technology consultants for this IS implementation. As noted below, the output of the SSM methodology was a conceptual model of the implementation activity. The research value of this SSM conceptual model was to identify two sets of variables that could be measured and utilized in the second, quantitative phase of this study. Therefore, one contribution of this study was to use the soft methods and techniques (SSM) in conjunction with the quantitative methodologies DEA and statistics. DEA can be used when comparing organizations or projects with multiple input and output variables. No underlying assumptions for input and output variables are required as with regression or other parametric techniques. Also, researchers can distinguish between efficient and inefficient organizations or projects. The statistical procedure of cross tabulations was then performed to identify the relative occurrence of efficiency and inefficiency of projects against the appropriate variable in each of five propositions explored in this study. It was felt that this combination of multi-methodologies expands the systems research experience by showcasing the mixing of these methods.

These efficiency measures and implementation factors identified through SSM analysis are the focal issues of this study. These measures and factors were incorporated into the questionnaire that was distributed to the sample of participating adoptive organizations, and the results of that survey were analyzed through the use of the quantitative methodology DEA and statistical analysis. The results of these quantitative analyses are addressed in a later section of this study.

2.2 Measuring the Implementation Efficiency of Consultants

The literature on measuring how well consultants perform is limited. One reason for this lack of cumulative knowledge is that measurement of consultant outcomes is a difficult problem to research. This difficulty stems from the fact that the researcher must deal with two complex issues: measurement and data. First, in order to measure how well a consultant's implementation is done relative to another implementation (the relative efficiency of implementation), the inputs and outputs of their role in the implementation process must be defined, and then analyzed. A relatively efficient or more successful implementation by a consultant produces more desirable output while utilizing the same input or the same output using less input than implementations by other consultants. The previous section described the use of Soft Systems Methodology (SSM) as a model building technique, to define appropriate surrogate variables that quantify these inputs and outputs related to the consultants' intervention.

Second, since a cross-functional technological innovation's implementation outcome is realized by the organization as a whole, the consultant's impact upon its success must be measured at the organization level of analysis. This necessity contributes to the lack of quality data on consultants' performance. Data from a sufficient number of organizations for empirical analysis is difficult to obtain. Often, firms are reluctant to divulge this data due to strategic or competitive reasons. One of the unique aspects of this study is its broad, cross-sectional sample, which is addressed in a subsequent section in this study.

Propositions

Based on the analysis performed using SSM which is summarized in the Activity Model of Information Technology Implementation shown in steps 1 and 3 of Figure 2, three sets of propositions can be formulated.

1. Influence of the organization's environment on efficiency of technology innovation implementation.

The environment relates to an organization's surroundings and has dimensions of industry regulation, organization size and organization type. This set of propositions is generally based on the open systems concept of general systems theory (von Bertalanffy, 1968), which holds that the parts cannot be understood without an understanding of the whole.

Proposition 1a. **An organization faced with an unregulated external environment will exhibit higher efficiency in implementation than an organization faced with a more regulated external environment**. Management, in carrying out the combination of input, process, and output functions of the organization, does so under a number of constraints from the external environment (Schoderbek, et. al. 1990). An organization which is subject to greater constraints from its environment, as in the case of governmental agencies or union regulations, will have less flexibility in altering its processes. As a result, the organizations with an environment that is less regulated, should be more efficient in implementing an IT innovation such as Information Engineering.

Proposition 1b. **An organization with fewer employees will exhibit higher efficiency in implementation than an organization with more employees**. There are three main inputs to any organization: people, materials and equipment, and money. These three inputs are drawn from the external environment, they are processed, and the resulting outputs of the organization are exchanged in the marketplace for money (Schoderbek, et. al. 1990). As noted above labor is one of the organization's input variables, and an organization which has fewer employees, will have more flexibility in altering its processes. Schumacher (1973) points out that many smaller business units are highly prosperous and provide society with most of the really useful new developments. As a result, the organizations with fewer employees, should be more efficient in implementing an IT innovation such as Information Engineering.

Proposition 1c. **An organization performing services as a primary business activity will exhibit higher efficiency in implementation than an organization performing manufacturing as a primary activity**. As noted above labor, as well as materials and equipment, are two of the organization's input variables. An organization has considerably more control over the input variable labor, than it has over materials and equipment (Schoderbek, et. al. 1990). An organization which performs services as its primary business activity, will have more flexibility in altering its processes, then an organization which performs manufacturing as its primary business activity. As a result, the organizations which perform services as their primary business activity, should be more efficient in implementing an IT innovation such as Information Engineering.

2. Influence of the characteristics of the innovation itself on efficiency of technology innovation implementation.

The innovation's characteristics relate to the innovation itself, and as such are unique for each innovation. In the case of information technology innovation, the characteristics of the innovation include the software that can be developed in-house or purchased from a vendor.

Proposition 2a. **An organization utilizing an information system (IS) software developed in-house will not exhibit higher efficiency in implementation than an organization utilizing an IS software purchased through a vendor.**

3. Influence of the type of consultant used on efficiency of technology innovation implementation.

In order to implement an innovation, a company often needs to merge the skills and expertise they already possess with the complementary skills and expertise contributed by other firms. External consultants come from outside the company, stay for the duration of the contract, and then leave (Kleiner, 1992). However, the use of external consultants bring with it both benefits and costs, and there is an alternative to utilizing external consultants. Over time and given sufficient financial resources, a firm can internally develop the expertise, which initially requires the use of complementary relationships. As used in this study, an internal consultant is a technological development professional, employed full time by the organization, and reporting to a senior manager (Lacey, 1995).

Proposition 3a. **An organization utilizing internal consultants will exhibit higher efficiency in implementation than an organization utilizing external consultants.**

3. RESEARCH METHOD

The overall objective of this study is to contribute answers to the research question: "Which of the propositional variables were related to information systems implementation in the more efficient adopting organizational units?" This study is conducted at the organizational level: the units of analysis are organizations and outputs are organizational outcomes.

The research variables were derived from the analysis performed using SSM, which is summarized in the Activity Model of Information Technology Implementation shown in Step 7 of Figure 2, including two input variables and two output variables, and is more fully described below.

Input Variables

Input 1 Actual Cost: The study used an objective measure of the amount of total expenditures, in dollars (US), of the technology and the consultants' services necessary to implement information systems in the adopting organization. The questionnaire utilized an open-ended question asking for the amount spent for software and consultants.

Input 2 Elapsed Time: The study used an objective measure of the actual time taken, in months, to implement information systems in the adopting organization. The questionnaire utilized an open-ended question asking for the dates of initiation and completion of the implementation, from which the elapsed time was computed.

Output Variables

Output 1 Degree of Difficulty: The study used a subjective measure of the degree of difficulty necessary to implement the technological innovation derived from a question asked of the respondents. The question was designed to measure the MIS manager's perception of the degree of difficulty performed by the consultant in implementing the technological innovation. The questionnaire utilized a scale from 0 to 10, with a "0" indicating "Low Difficulty," and a "10" indicating "High Difficulty."

Output 2 Perceived Satisfaction: The study used a subjective measure of the perceived satisfaction of the information technology innovation derived from a question asked of the respondents. The question was designed to measure the MIS manager's perceived satisfaction with the information system implemented. The questionnaire utilized a scale from 0 to 10, with a "0" indicating "Low Success," and a "10" indicating "High Success."

Propositional Variables

Proposition 1a Regulated Environment: The study used an objective measure of the industry in which the implementing organization operated. The questionnaire utilized an open-ended question asking for the primary industry of the organization. Subsequently, the researchers segmented the respondents based on regulated and unregulated environments.

Proposition 1b Number of Employees: The study used an objective measure of the amount of total employees in the implementing organization. The questionnaire utilized an open-ended question asking for the number of employees in the organization. Subsequently, the researchers segmented the respondents into small (< 1000), medium (1000 - 5000) and large (> 5000) organizations.

Proposition 1c Primary Business Activity: The study used an objective measure of the primary business activity of the implementing organization. The questionnaire utilized an open-ended question asking for the type of organization. Subsequently, the researchers segmented the respondents based on service and manufacturing activities.

Proposition 2a IS Software: The study used an objective measure of the IS software used by the implementing organization. The questionnaire utilized an open ended question asking for the IS software used. Subsequently, the researchers segmented the respondents based on software developed in-house and those purchased from a vendor.

Proposition 3a Type of Consultant: The study used an objective measure of the type of consultant used by the implementing organization. The questionnaire utilized an open-ended question asking for the type of consultant used. Subsequently, the researchers segmented the respondents based on the use of internal versus external consultants.

3.1 Methodology

The data was analyzed in two steps. The efficiency of each organization's IS implementation was ascertained first utilizing Data Envelopment Analysis (DEA). This was followed by further analysis of the organizations, segmented according to efficient and inefficient firms, to determine whether or not efficiency measures differ with respect to the variable of interest in each proposition. To assess the relative contribution of each variable of interest to the efficiency of IS implementation, the statistical method cross-tabulations was employed, utilizing the SPSS statistical software package.

DEA is an excellent technique for analyzing data pertaining to efficiency for several reasons. First, no underlying assumptions for input and output variables are required as with regression or other parametric techniques. Second, DEA allows managers of these organizations to consider multiple input and output scenarios for information systems implementation. Third, managers can distinguish between efficient and inefficient IS implementations. Fourth, DEA can be used to determine the specific inefficiencies in IS implementation that is not possible with parametric regression techniques (Sengupta and Sfeir 1988, Banker, Charnes, Cooper, and Maindiratta 1988).

Next, the statistical method cross-tabulations was used to test the hypotheses that the two variables in each proposition were independent of each other. If they are independent, then no relationship exists between them. However, if the test results in rejection of the null hypothesis, then a relationship may exist between the two variables. This method requires that the data be segmented into classes for each variable. In this study two classes were required for the efficiency variable: efficient versus inefficient for efficiency results. Additionally, the variable of interest for each proposition was segmented into at least two classes as outlined above.

3.2 Sample

This study is part of a larger cross-sectional mail survey involving 146 different information systems (IS) implementations. The targeted respondents were information systems (IS) managers who supervised a work group actively using an IT innovation for at least six months. The survey was aimed at IS managers, since they were expected to be the most appropriate informational sources due to their managerial position and comprehensive knowledge of their respective organization, work group, and information system.

A proprietary, master list of organizational sites in the United States that were known to have experience with IS development was made available to the researchers, on a confidential basis, through the cooperation of a major technological innovation developer active in IS development. No restrictions or limitations were placed on the research by the benefactor firm.

This proprietary list consisted of 196 organizations, actively using IS development, which are geographically dispersed throughout North America and exhibit a wide diversity of both organizational types and primary business functions. The key criterion for sample selection was organizational experience with IS development technology.

Of the 196 companies included on the proprietary list supplied to the researcher, 50 were unable to participate which resulted in an effective sample size of 146 organizations. A survey questionnaire was mailed to each IS manager of the sample group along with a cover letter and stamped, self-addresses return envelope. In both the cover letter and the survey instructions, all respondents were promised anonymity, as well as a copy of survey results. A reminder was sent several weeks after the initial mailing. To assess nonresponse bias, comparisons between early and late respondents were made with respect to the type of the prospective respondent's organization. None were noted.

Seventy-seven questionnaires were returned by the managers, representing a response rate of 53%. However 41 respondents returned questionnaires which were incomplete or otherwise not usable for this study. This reduced the effective number of usable questionnaires received from respondents to 36. The composition of the sample respondents is displayed in Table 1. Based on two chi-square tests performed on the compositions of the source, sample, and respondents, there did not appear to be any nonresponse bias as to the distribution of organizational type. A majority (59%) of responses were from commercial organizations. Other respondents were from utilities (22%), government agencies (16%), and education organizations (3%).

Table 1. Composition of Sample Respondents

Industry Classification	Respondents n (%)
Manufacturing	9 (25)
Banking/Finance	5 (14)
Insurance	4 (11)
Retail	1 (3)
Transportation	2 (6)
Utilities	8 (22)
Education	1 (3)
Government Agencies	6 (16)
Total	36 (100)

4. RESULTS

4.1 Implementation Efficiency of Organizations

The efficiency of each organization’s IS implementation was ascertained using DEA (Table 2). The DEA analysis compares all 36 organizations to one another to determine the relative efficiency of each organization’s IS implementation. An organization is relatively efficient if some other organization, in the 36 under consideration, cannot be found that produces more output while utilizing the same input or the same output using less input. A data scaling technique as proposed by Haag, Jaska, and Semple (1992) was used in the DEA analysis to help smooth any effects of large or small input or output variable values in the efficiency analysis.

Table 2. Organization Input/Output Categories and Efficiency Results

	INPUTS		OUTPUTS			
Organization	$(000) Spent	Time	Deg. Diff.	Per. Suc.	Consultant	Efficiency
1	140	15	1	4	External	1.0000
2	825	26	6	4	External	.6883
3	850	14	8	6	External	1.0000
4	230	21	8	6	Internal	1.0000
5	5,750	42	4	4	External	.4118
6	50	48	8	5	Internal	1.0000
7	17,500	31	6	4	External	.2468
8	270	73	6	1	External	.5371
9	100	65	8	3	External	.7638
10	1,000	52	10	2	External	.7067
11	255	29	4	2	External	.6470
12	70	32	7	3	Internal	1.0000
13	13,500	53	10	2	External	.3285
14	1,150	57	5	6	External	.6033
15	78	37	7	5	External	1.0000
16	560	21	8	6	External	.8707
17	170	45	4	2	External	.6562
18	2,550	49	10	5	External	.6964
19	11,500	72	8	3	External	.2940
20	300	56	7	6	External	.7041
21	460	24	1	1	External	.5493
22	325	78	8	3	External	.5780
23	2,500	24	7	7	External	.6873
24	580	29	10	6	External	.8108
25	3,000	75	7	7	External	.5225
26	80	30	2	7	External	1.0000
27	775	56	3	10	Internal	1.0000
28	450	67	6	7	External	.6615
29	560	66	3	9	External	.8825
30	3,200	51	8	4	External	.5247
31	300	15	8	7	External	1.0000
32	195	29	7	6	External	.9445
33	450	36	7	6	External	.7731
34	600	25	5	4	External	.6847
35	430	35	8	6	External	1.0000
36	2,500	24	2	8	External	1.0000

Using the two input measures (total money spent and time spent) and the two output measures (perceived success and degree of difficulty), the relative efficiency was computed for the 36 organizations included in this sample from the DEA analysis. All organizations that were rated 1.00 are classified as efficient and those with ratings less than 1 are classified as inefficient. In Table 3, the efficient organizations are detailed.

Table 3. Description of Efficient Organizations

	INPUTS		OUTPUTS			
Organization	$(000) Spent	Time	Degree of Difficulty	Perceived Satisfaction	Consultant	Efficiency
1	140	15	1	4	External	1.0000
3	850	14	8	6	External	1.0000
4	230	21	8	6	Internal	1.0000
6	50	48	8	5	Internal	1.0000
12	70	32	7	3	Internal	1.0000
15	78	37	7	5	External	1.0000
26	80	30	2	7	External	1.0000
27	775	56	3	10	Internal	1.0000
31	300	15	8	7	External	1.0000
35	430	35	8	6	External	1.0000
36	2,500	24	2	8	External	1.0000

In Table 4, the DEA relative efficiency results for the sample of 36 organizations are summarized. Out of the thirty-six organizations analyzed, eleven (30.56%) were found to be efficient. The remaining 25 (69.44%) inefficient organizations had efficiency ratings ranging from 0.9445 to 0.2468.

Table 4. DEA Efficiency

Efficiency Rating Scale	Number of Organizations	Percentage (%)
1.0000	Efficient 11	30.56
Less than 1.000	Inefficient 25	69.44
Total	36	100.00

In Table 5, a comparative analysis of efficient and inefficient organizations with regard to average input and output levels is given. Efficient organizations, on average, spent less money and time than inefficient organizations ($500,000 compared to $2,700,000 and 29.7 months compared to 47 months). Perceived success, on average, was much higher for efficient organizations (6.1 compared to 4.4), but the average degree of difficulty was less for efficient organizations. Considering the sum of the average overall outputs for efficient organizations (11.73) and inefficient organizations (11.00), efficient organizations on average do better than inefficient organizations.

Table 5. Comparative Analysis of Efficient and Inefficient Organizations

Organizations	Average Amount of Money Spent	Average Elapsed Time	Average Perceived Success	Average Degree of Difficulty
Efficient	$500,000	29.7	6.1	5.6
Inefficient	$2,700,000	47	4.4	6.6

4.2 Cross-Tabulations Results

To assess the relative position of efficient versus inefficient organizations implementing IS pertaining to key variables, a series of cross-tabulations was run. For this analysis, all thirty-six organizations displayed in Table 2 were retained in the sample (n=36). The variables of interest are the organization's efficiency rating and the appropriate variable for each of the five propositions. The thirty-six organizations were segregated by type of efficiency rating: the efficient organizations, comprised of eleven subjects (n=11) representing approximately 30 percent of the total sample; and inefficient organizations, comprised of twenty-five subjects (n=25) representing approximately 70 percent of the total sample.

Next, the relative occurrence of efficiency and inefficiency was statistically tested against the appropriate variable in each of the five propositions by the method cross-tabulations, and the results are summarized in Table 6 through Table 10. Two statistics are reported: the chi-square test of independence and Fisher's exact test. The Pearson Chi-square statistic involves the differences between observed and expected frequencies. The null hypothesis that the two variables are totally independent, and the alternative hypothesis is that the two variables are associated. For this analysis, alpha = 0.10 represents the significance level for rejecting the null hypothesis of no association. Fisher's exact test, a nonparametric method based on the hypergeometric distribution, is an alternative test of independence for two variables. It is most useful when the sample sizes are small, as they are in this study.

Analysis of the Organization's Environment

An examination of Table 6 reveals a significant association between regulated environment and implementation efficiency. For organizations operating in both non-regulated and regulated environments, the majority is represented in the inefficient category. However, those organizations in a non-regulated environment are more than nine times as likely to be categorized as efficient (28%) as those in a regulated environment (3%). This relationship is significant (p = .009).

Table 6. Analysis of Efficiency Results by Regulated Environment (n=36)

Efficiency Results	Regulated Environment	
	Non-Regulated	Regulated
Inefficient Implementation	11 (52%)	14 (93%)
Efficient Implementation	10 (48%)	1 (07%)

Pearson Chi-square with 1 degree of freedom = 6.916, p = .009*
Fisher's Exact Test - p = .011*
* Statistically significant at p = 0.10

The relationship between number of employees and implementation efficiency is depicted in Table 7. For both small and large organizations, the majority are represented in the inefficient category. However, small organizations are more than three times as likely to be categorized as efficient (29%) as large organizations (9%). This relationship is significant (p = .044).

Table 7. Analysis of Efficiency Results by Type of Consultant Used (n=36)

Efficiency Results	Type of Consultant		
	Small	Medium	Large
Inefficient Implementation	12(71%)	3(38)	10 (91%)
Efficient Implementation	5 (29%)	5(62)	1 (09%)

Pearson Chi-square with 1 degree of freedom = 6.246, p = .044*
Fisher's Exact Test - N/A
* Statistically significant at p = 0.10

Table 8 reveals a somewhat uniform pattern of primary business activity for both efficient and inefficient organizations. The statistics reflect this lack of association. The relationship between primary business activity and implementation efficiency is not significant at alpha = 0.10.

Table 8. Analysis of Efficiency Results by Type of Primary Business Activity (n=21)

Efficiency Results	Primary Business Activity	
	Manufacturing	Service
Inefficient Implementation	4 (44%)	7 (58%)
Efficient Implementation	5 (56%)	5 (42%)

Pearson Chi-square with 1 degree of freedom = 0.398, p = .528
Fisher's Exact Test - p = .425

Analysis of the Characteristics of the Innovation Itself

Table 9 summarizes the lack of a relationship between the innovation characteristic IS software adopted by the organization and implementation efficiency. The statistics reflect this lack of significant differences as proposed above. The relationship between IS software used and implementation efficiency is not significant at alpha = 0.10.

Table 9. Analysis of Efficiency Results by Characteristic of IS Software (n=36)

Efficiency Results	IS Software	
	In-House	Vendor
Inefficient Implementation	6 (75%)	19 (68%)
Efficient Implementation	2 (25%)	9 (32%)

Pearson Chi-square with 1 degree of freedom = 0.150, p = .699
Fisher's Exact Test - p = .532

Analysis of Internal Versus External Consultant's Contribution

Table 10 reveals that 100 percent of the organizations using internal consultants were efficient. Organizations that used internal consultants (100 percent) were more that four times as likely to achieve efficiency than those that used external consultants (22 percent). This represents a statistically significant relationship, at alpha = 0.10, between the use of internal consultants and the efficient implementation of the technological innovation.

As the chi-square statistics reveal, the use of internal consultants during implementation of a technological innovation does result in a higher level of implementation efficiency. These results suggest that further research related to the use of technological consultants would be beneficial to IS managers who are contemplating the adoption of similar innovations.

Table 10. Analysis of Efficiency Results by Type of Consultant Used (n=36)

Efficiency Results	Type of Consultant	
	External	Internal
Inefficient Implementation	25 (78%)	0 (0%)
Efficient Implementation	7 (22%)	4 (100%)

Pearson Chi-square with 1 degree of freedom = 10.227, p = .001*
Fisher's Exact Test - p = .006*
*Statistically significant at p = 0.10

5. DISCUSSION OF RESULTS

From the results of this study a description of an efficient organization in the implementation of information systems begins to emerge. Efficient organizations were able to achieve much higher perceived success with a moderate degree of difficulty. These outputs were obtained with much less money spent over a shorter length of elapsed time. These results suggest that it is feasible to achieve positive benefits from the technical innovation while limiting the amounts of both time and money at risk. These results are consistent with Vrakking (1995) who found that the chances of successful implementation of innovations in general increase if the time to implement is minimized.

These findings are important to managers considering the adoption of technical innovations. They need to move swiftly and understand that delays can have negative consequences in terms of outcomes. Additionally, throwing resources, in terms of money, at the implementation does not increase the chances of successful outcomes.

Impact of the Organization's Environment Upon Efficient Implementation

As expected, the empirical results support a significant association between regulated environment and implementation efficiency. These results are consistent with the observations made by Reagan (1990) that a regulated environment is seen to stifle innovation.

Again as expected, the results indicate a relationship between the size of an organization and the efficiency of innovation implementation. The smaller organizations enjoy a more efficient implementation, whereas larger organizations are less efficient in implementing IS.

These results related to the external environment add to the picture of the efficient firm in implementing IS. The efficient organization tends to be a small-to-medium sized firm operating in a non-regulated environment, but the further distinction between manufacturing and services as a primary business activity does not appear significant.

Impact of Type of IS Development Upon Efficient Implementation

As expected the impact is not significant for IS software adopted. The findings that no significant differences resulted from this study indicates that the choice made by the participating organizations in their implementation of In-House or Vendor developed software had no effect on their relative efficiency.

External versus Internal Consultants in Innovation Implementation

The results of this study suggest that the internal consultant is able to achieve results that are comparable to the results of their external counterparts. To a manager, this means that the lower costs and risks of utilizing the consulting services of internal staff may be beneficial to the organization since the success of the implementation outcomes were comparable with those of external consultants.

6. CONCLUSIONS AND SOME LIMITATIONS

Due to the exploratory nature of this study and the need for a flexible methodology, a multi-methodology design using SSM and DEA was employed. SSM analysis was used to examine the real-world human action of the implementation of a technical innovation from the widely differing viewpoints of the individuals involved. SSM enabled the researchers to identify the culturally feasible and systematically desirable measurement criteria and external and internal factors related to the success of the innovation's implementation. The appropriate surrogate variables, which were identified through the application of SSM, were incorporated into a questionnaire that was distributed to participating adoptive organizations, and the results of that survey were analyzed through the use of the quantitative methodology DEA and statistical analysis. The use of SSM and DEA provided a means of analyzing the productivity of consultants from an organizational perspective.

The paucity of empirically derived knowledge addressing the productivity of a consultant from the organization's perspective is the fundamental driver of this study. Since information flows throughout the organization, the implementation of an IT innovation in the process of developing new information systems can be expected to impact multiple levels of the organization. Therefore, the organizational level of analysis is appropriate for this study, and data was collected from many organizations throughout North America.

The cross sectional sample in this study was chosen for its diversity, and includes organizations from both the profit and non-profit sectors, from different industries within the profit sector, and from firms of various sizes. A limitation of this organizational approach is found in the lack of control of possible confounding variables in areas such as organizational factors, departmental issues, and IS project dimensions.

A major limitation of this study stems from the relatively small sample size. It is large enough to provide representation, but too small to allow exploration of the effect individual consulting firms may have on implementation efficiency. In this sample, the three most costly projects are inefficient. Since the sample size is small, this indicates the need for further research in comparing small and large expenditure projects. Also, additional research is needed to further understand the impact of consulting firms on the technology innovation implementation process.

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Received: 17 December 2002
Accepted in final form: 19 December 2003 after two revisions

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