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The Benefits of Using Information Systems

ARIK RAGOWSKY, NIV AHITUV, AND SEEV NEUMANN

Information systems are vital to the operation and management of every organization. Managers investing in IS are interested in the benefit their organizations gain from this investment. However, neither managers nor researchers have found a way to justify investment in IS based on its contribution to an organization's performance. Most studies examining the relationship between IS and performance level have found no positive relationship between the two variables [7]. But these studies have been holistic, relating the total IS investment—software, hardware, personnel—to the total profit of the organization.

Our study now suggests that the analysis should be particulate, not holistic. An organization should not look for benefits by viewing the IS applications portfolio as one entity. Benefits should be found for each individual area of activity/IS application (such as suppliers and purchase orders, customers, and sales) as a function of the organization's characteristics. Hence, IS managers should justify the investment in each IS application, not in the entire IS application portfolio.

A 1985 study that examined service sector firms found no significant relationship between investment in IS and high performing firms [12]. A 1992 study found a "statistically significant negative relationship between productivity growth and the high-tech intensity of the capital" [4]. However, it also pointed out that the negative results may have been due to measurement problems. In 1993, Brynjolfsson summarized this issue: "It is possible that the benefits of IT investment are quite large, but that a proper index of its true impact has yet to be analyzed," adding that "The lack of good quantitative measures for the output and value created by IT has made the MIS manager's job of justifying investments particularly difficult" [5]. We offer other measurements and a different approach to identifying and evaluating the benefits derived from IS investment.

Since business performance is measured by profit, managers need to assess the benefit of IS investment by answering two questions:

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- What benefits should organizations expect from IS?
- What variables predict or explain these benefits?

One resolution to these difficulties is to use a large sample with firm-level data, where evidence of productivity is based on the assessment of someone in the firm. Such an approach must take organizational characteristics like lead time, throughput time, and lot size into account, since these characteristics determine the benefits to be gained from IS [10]. In 1985, Porter argued that "competitive advantage cannot be understood by looking at a firm as a whole. It stems from many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its products. Each of these activities can contribute to a firm's relative cost position and create a basis for differentiation" [9]. Following Porter's approach, we reason that IS benefits should be measured separately for each area of activity within the organization (such as purchasing, customer management, and production management), and hence, for each IS application.

In this article, we assert the following two hypotheses:

- No significant relationship exists between the organization's characteristics and the overall benefit the organization gains by using the entire IS (all the IS applications portfolio as one entity).
- A significant positive relationship exists between organizational characteristics and the benefit the organization may gain by using a specific IS application.

These hypotheses are derived from the fact that the overall benefit an organization may gain from IS (when dealing with the entire IS applications portfolio of the organization) is too general, and can be neither predicted nor explained by the organization's characteristics. Hence, a manager cannot use it to justify investment in IS. Organizational characteristics that have impact on performance such as lead time, throughput time, and lot size [3], do not impact the benefit gained from using the entire IS application portfolio.

In order to explain or predict the benefit an organization gains from IS, the definition of the benefit must be more precisely focused. Unlike the total benefit from IS, the benefit an organization may gain from a specific IS application is well focused, and hence, can be predicted or explained by the organization's characteristics. A manager can consequently use this benefit to justify investment in IS.

How the Study Was Conducted

Our research is based on a sample of 310 Israeli manufacturing organizations. Interviews by structured questionnaires were conducted during May 1991–March 1992. The questionnaire was divided into two sections. The first included questions about organizational characteristics (such as number of suppliers, relative share of raw materials cost in the cost of the final product, number of customers, average lead time to customers, number of products, number of production lines, volume of sales, number of employees). In the second section the respondents—all senior managers who used IS—were asked to assess benefits derived from IS as a whole, as well as from each of several key IS manufacturing applications. Respondents were asked to rank benefits on semantic scales generally ranging from 1 to 7, a well-tested method for measuring perceived benefit [1].

We chose to measure perceived, rather than real benefit because during a pilot test we found we could not determine the real benefit from IS. This information was either

unavailable or not released by respondents. A 1989 study found that "Despite its limitations, the perceived value is very instrumental in assessing the value of an IS that supports unstructured decisions where the outcomes are somewhat intangible or planned for long range" [1].

The sampled organizations were randomly selected from the *1990 Annual Survey of Manufacturing Companies*, published by the Central Bureau of Statistics in Israel. The companies in the sample varied widely in their characteristics. The questionnaire included 103 variables that characterized the companies, six of which are presented in Table 1.

We used regression analysis to examine the research hypotheses using several scenarios. In one, the benefit of the entire IS applications portfolio as assessed by respondents represents the dependent variable. In another, benefits of individual IS applications represent the dependent variables. In both cases, the organization's operational characteristics represent the independent variables.

Based on Porter's theory mentioned previously, each activity area is characterized by organizational characteristics, such as average number of purchase orders per month for the purchasing activity area, and supply time to customers for the sales activity area. Bartezzaghi and Francesco have argued that organizational performance depends on organizational characteristics such as lead time, throughput time, lot size, capacity utilization, percentage of defects, and manpower efficiency [3]. To determine the IS benefit to organizational performance, we used these characteristics as the independent variables for our analysis. These characteristics have a significant impact on the benefit from using an individual IS application, but very little impact on the total organizational benefit from using the entire information systems. This article will demonstrate that organizations should estimate the benefit derived from individual IS applications and not from the entire IS applications portfolio when planning the investment in IS.

IS can benefit the organization by reducing the uncertainty/complexity of decision-making, especially for decisions that have a significant impact on the organization's

	Min.	Max.	Median	Mean	St. Dev.
Volume of 1990 sales (in million $ U.S.)	1	400	33	41.78	39.52
Number of employees	10	2400	100	200	321
Number of suppliers	1	5000	45	177	526
Relative share of raw materials in the cost of the final product	2%	85%	44%	43.65%	15.31%
Number of customers	1	10,000	150	672	1746
Average lead time to customers (in days)	1	720	15	39	73.91

Table 1. Distribution of the respondent organizations' characteristics.

objectives [8, 10]. An organization uses IS to obtain information that furthers the organization's objectives [2]. Benefits derived from IS applications are a function of at least two conditions: (1) the amount of diversity, variety, variability, or uncertainty/complexity contained in the information set on which a decision rule is based, and (2) the impact that the decision, supported by the added information supplied by the IS application, has on the organization's objectives.

As uncertainty/complexity increase, more information needed by the decision maker. Expanding the scope of IS increases information, but it does not necessarily increase the value of the information. If a decision area has little impact on the organization's objectives, additional information provides only marginal benefits.

A given area of the organization may involve a high degree of uncertainty, but with a low impact on the organization's objectives. Consider an organization that uses many raw material suppliers, and that has a corporate strategy of cost reduction. Differences exist among the suppliers (different prices, lead time, quality, and so forth), and no particular supplier is preferred. Much supplier data must be examined to decide which supplier to use for each purchase order.

Since a manager can reduce purchasing and raw material cost approximately 15% by using a computerized application to make this decision [11], it may be justified to implement a suppliers and purchase order IS application to reduce this source of uncertainty. But if the raw materials cost of the product is small relative to labor and other costs, then even the best decision concerning suppliers will have little impact on the organization's cost-reduction strategy. For instance, if the materials cost is 5% of total costs of the product, the savings will be 0.75% (15% times 5%). In this case, the information about suppliers is not particularly valuable, even though the level of uncertainty/complexity concerning suppliers is high.

It is reasonable to assume that variables representing the level of uncertainty/complexity and variables representing the impact of the decision supported by the additional information on the organization's objectives and strategies may be used to demonstrate the benefit from IS. Many such variables exist; in this preliminary study we examined 10 of them:

1. *The relative share of cost of raw material in the overall cost of the final product.* By using IS, an organization can better negotiate with suppliers and reduce the cost of raw materials by about 15% [11]. Hence, the higher the relative share of cost of raw material in the cost of the final product, the greater the savings for the organization, and the greater the benefit of the information provided by the computerized application. This variable represents the impact of the decision supported by the additional information on the organization's objective with respect to the suppliers and raw material purchase orders activity area.
2. *Differences among suppliers.* Suppliers differ in terms of price, quality, supply, and lead time. The more differences among the suppliers regarding these attributes, the greater the amount of information needed for choosing the best supplier for a specific purchase order. This variable represents the level of uncertainty/complexity with respect to the suppliers and raw materials purchase orders activity area.
3. *The average lead time of raw materials.* The longer the lead time, the greater the probability of changes, such as greater demand for the raw material, or partial or full cancellation of the order. The longer the lead time, the greater the amount of information needed to manage the purchase orders. This variable represents the level of uncertainty/complexity with respect to the suppliers and raw materials purchase orders activity area.

4. *The price elasticity of raw materials.* Suppliers sometimes offer a quantity discount. The greater the price elasticity, the more information needed to obtain the best purchase order. This variable represents the level of uncertainty/complexity with respect to the suppliers and raw material purchase orders activity area.
5. *The supply time for customers.* One way to increase sales volume is to shorten the supply time for the customers. The shorter the supply time, the higher the sales volume a manufacturing company can generate with fixed manufacturing facilities [6]. Using a computerized IS application helps the organization to supply orders on time and/or to shorten the supply time. The longer the supply time, the greater the benefit of the information provided by computerized IS. This variable represents the impact of the decision supported by the added information on the organization's objective with respect to the customer order activity area.
6. *The complexity of the product.* Three kinds of products exhibit different degrees of complexity. With standard products, such as food on store shelves, customers cannot ask for product changes. Customer orders need only consist of data regarding the quantity and supply date. It is not difficult to trace the customer orders regarding the complexity of the product. Standard products with modifications, such as furniture that can be adapted to the customer's specifications are slightly more complex. It is necessary to manage information on the specifications to make sure that changes have been performed. Custom-designed products represent the highest level of product complexity. The organization must address product design, raw material purchase, and scheduling. The greater the product complexity, the more information is needed to manage customer orders. This variable represents the level of uncertainty/complexity with respect to the customer order activity area.
7. *The average time raw material inventory remains in the organization.* Manufacturers can save 25–30% of inventory carrying costs (financing, storing, insurance, and so forth) by using computerized IS [11]. The longer the raw material inventory remains in the organization, the higher the potential for cost saving. This variable represents the impact of decisions supported by IS with respect to material requirement planning.
8. *The average number of levels in the bill of materials of the firm's products.*
9. *The average duration of a work order.*
10. *The number of production lines.*

Results

The first set of results concerns the attempt to explain the benefit of the entire IS applications portfolio in terms of the operational characteristics of the organization by using regression analysis. The results of the regression are shown in Table 2.

As can be seen from Table 2, among the 10 independent variables, only two have a significant impact on the dependent variable ($t > 2$). Yet, R^2 is very low (6.9%), which means the variables representing the organization's operational characteristics do not significantly explain the overall benefit the organization gains from the entire IS. These results support the first research hypothesis. As mentioned earlier, we used organizational characteristics that support the organizational performance as independent variables. Since these variables do not explain the dependent variable (the total benefit derived from using the entire IS applications portfolio), IS managers cannot use this benefit to justify investment in IS.

If our second hypothesis is correct, the benefit derived by using a specific IS application should be more precisely focused, unlike the benefit from using the entire IS applications portfolio, which is too general. We will present the analysis of the suppliers and

The Independent Variable	Overall Benefit Coefficient
Relative share of cost of raw materials in the overall cost of the final product	-0.053 (0.855)
Average lead time of raw materials (in days)	0.144 (2.226)
Price elasticity	0.014 (0.22)
Differences among the suppliers	-0.154 (2.497)
Supply time for customers (in days)	0.078 (1.064)
The product complexity	-0.085 (1.374)
Average time raw material inventory remains in the organization (in days)	-0.002 (0.027)
Average number of levels in the bill of material of the firm's product	0.058 (0.965)
Average time of a work order (in days)	-0.129 (1.81)
Number of production lines	0.056 (0.937)
R-square	0.069

Note: t-statistics are in parentheses

Table 2. Regression results for the benefit the organization gains from the entire IS as a function of the organizational operational characteristics.

purchase order area of activity/IS application as an example. This methodology can be used for any application after identifying the relevant organization's characteristics.

The suppliers and purchase order system manages all the details regarding the organization's suppliers, and each raw material purchase order. By using this information the organization can obtain the best prices for raw materials and receive the supply as close to the date needed as possible. The independent variables for this application are:

- The relative share of cost of raw material in the overall cost of the final product;
- The differences among the suppliers;
- The average lead time of all the raw materials the organization uses; and
- The price elasticity of raw materials.

As Table 3 shows, the independent variables explain about 40% of the variance of the benefit an organization may gain by using the suppliers and purchase order application. All of the independent variables have significant impact on the dependent variable ($t > 2$). These results support the second research hypothesis. We formulated a prediction equation that determines the benefit from using the suppliers and purchase order application, as follows:

Y - The benefit the organization can gain by using the application.
X_1 - Relative share of cost of raw materials in the overall cost of the final product.
X_2 - Average lead time of raw materials.
X_3 - Price elasticity.
X_4 - Differences among the suppliers.
$Y = (0.45599488)X1 + (0.2488845)X2 + (0.21797468)X3 + (0.12501663)X4$

The Independent Variable	Coefficient	t-statistic
Interoept	0.00000	1.124
Relative share of cost of raw materials in the overall cost of the final product	0.45599488	10.16 (**)
Average lead time of raw materials (in days)	0.24288845	5.385 (**)
Price elasticity	0.21797468	4.635 (**)
Differences among the suppliers	0.12501663	2.647 (**)

R-square = 0.3898

** significant values ($t > 2$)

Table 3. Regression results for suppliers and purchase application.

We conducted a similar analysis for the other areas of activity mentioned earlier (customers, MRP, and MRP II), and the results also supported the second research hypothesis.

Conclusion

We found no significant relationship between organizational characteristics and the overall benefit from the entire IS applications portfolio. This benefit was too general to be measured. However, we did find a significant relationship between the organizational characteristics and the benefit from specific IS applications. This study is one of few to examine the benefit an organization may gain by using IS and to relate this benefit to organizational performance.

Based on our findings, we recommend that managers consider each area of activity/IS application individually when determining the benefit from IS.[1] Also, the benefits an organization should expect from IS are operational benefits, such as cost reduction and increases in competitive capability. It is important to reiterate that these benefits must be very precisely focused. One must identify decision areas with high impact on organizational objectives and determine both the organizational characteristics that represent the impact of the decision (supported by the additional information provided by the IS application), and the organizational characteristics that represent the level of uncertainty/complexity with respect to this decision. Further studies should be conducted in this area. By using the approach and findings of this study and by expanding its scope, the benefit an organization can gain by using IS can be better identified, explained, and predicted. In addition, while this study focused on manufacturing organizations, the approach can also be used by organizations such as banks, insurance companies, and retailers.

References

1. Ahituv, N. Assessing the value of information: Problems and approaches. In *Proceedings of the Tenth International Conference on Information Systems*, Boston, 1989.

2. Ahituv, N., Neumann, S., and Riley, N. *Principles of Information Systems for Management, 4E.* Wm. C. Brown, Dubuque, Iowa, 1994.

3. Bartezzaghi, E. and Francesco, T. The impact of just-in-time on production system performance: An analytical framework. *International Journal of Production Management 9*, 8 (Mar. 1989), 40–62.

4. Berndt, E.R. and Morrison, C.J. High-tech capital formation and economic performance in U.S. manufacturing: An exploratory analysis. Economics, Finance and Accounting Working Paper #3419, Sloan School of Management, Massachusetts Institute of Technology, April 1992.

5. Brynjolfsson, E. The productivity paradox of information technology. *Commun. ACM 36*, 12 (Dec. 1993), 67–77.

6. Gunn, T. The CIM connection. *Datamation 32*, 3 (Sept. 1986), 8–11.

7. Kauffman, R.J. and Weill, P. An evaluation framework for research on the performance effects of information technology investment. *Proceedings of the Tenth International Conference on Information Systems*, Boston, Dec. 1989.

[1] It can be noted that, since all value in the firm must be derived from revenue outside of the firm, that it was expost logical to expect that the value of the support function (IS function) should be directly related to a value adding (cost reducing) activity.

8. Markus, M.L. and Soh, C. Banking on information technology, in Banker, D.R., Kauffman, J.R., and Mahmood, M.A., Eds., *Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage*, Idea Group Publishing, Harrisburg, PA, 1993.

9. Porter, E.M. *Competitive Strategy.* The Free Press, New York, 1985.

10. Ragowsky, A., Ahituv, N., and Neumann, S. A model for identifying the value and the importance of an information system application. *Information & Management 31*, 2, Nov. 1996, 89–102.

11. Schlack, M. IS has a new job in manufacturing. *Datamation* (Jan. 15, 1992), 38–40.

12. Strassmann, P. *Information Payoff: The Transformation of Work in the Electronic Age.* Collier Macmillan, London, 1985.