A SCIENTIFIC APPROACH TO THE MEASUREMENT OF IT BUSINESS VALUE - PART I: A MANAGER'S GUIDE TO 'BUSINESS VALUE LINKAGE' IMPACT ANALYSIS

by

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Introduction

In a recent interview with *Computerworld*, Stephen Roach, senior economist and principal at Morgan Stanley and Co., estimated that the service sector in the U.S. is spending nearly $120 billion per year on information technology (IT). He further estimates that IT amounts to about 42% of American corporations' budgeted expenditures on capital equipment. Traditionally, the place to look for justification for IT investments has been in a firm's operations. The purpose of many investments is to improve productivity and, thus, reduce operating costs. But, results of survey research done by Roach suggest that the service sector has invested nearly 2.5 times as much money in IT as the manufacturing sector in the last five years, while productivity growth is only .5% greater than the 4% average productivity gain seen in manufacturing. Thus, it is likely that many firms which invest in IT are looking elsewhere for payoffs.

Consider the following examples of actual IT investments which create business value in nontraditional areas:

- Mutual Benefit Life, an insurance company headquartered in New Jersey, is estimated to spend about $38 million per year on information systems. Its senior vice president for IS, Charles McCaig, puts an overall price tag of $500 million on the replacement value of the firm's IT assets. By 1986, the firm managed to reduce IT expenditures as a percent of the overall budget, while reducing staffing and dramatically increasing claims processed compared to a 1981 baseline. The cost of processing a claim fell by nearly 50%, and average turnaround time was reduced from about one month to just one week [5].
- First Boston Corp. invested $60 million to develop a computer-aided software engineering (CASE) tool that the firm has used to reconstruct its trading systems. It now plans to license the resulting system as a product called "High Productivity Systems" to Kidder Peabody, a major competitor, for an undisclosed fee. Meanwhile, First Boston is also evaluating whether to license the product to others [4].
- Otis Elevator Company invested heavily to centralize the handling of maintenance service calls for elevators it sells to large firms. As a result of this investment, Otis can track historical information about the performance of a particular elevator and identify the right set of resources within the company to maximize the quality of its service calls. This investment has enabled Otis to gain market share in the maintenance after-market and reduce service call costs [3].
- Citibank has recently spent heavily on the deployment of more than 600 second generation ATMs it calls "success machines." The bank had previously been known as a leader in electronic banking for deploying a very large proprietary ATM network in New York City in the 1970s, which helped the bank to increase substantially its share of the retail account market. Competing banks in New York City responded by forming a shared ATM network called the "New York Cash Exchange," and recently this competing network achieved critical mass. One result is that the competition has shifted to increasing the range of services offered at an ATM, and reducing a banking customer's waiting time by deploying multiple ATMs at each location.

The large amount of financial resources involved in the kinds of investments described above calls into question the kind of business justification managers have before making these investments, the formal evaluation procedures which discriminate among investment opportunities, and the form of the payoffs they expect. If productivity improvements are no longer thought to be the primary source of return, then

McFarlan's analysis is based on the work of Michael Porter, particularly his 1980 book entitled *Competitive Strategy: Techniques for Analyzing Industries and Competitors* [11]. Porter introduced a framework for competitive analysis, relating aspects such as barriers to entry, buyer-supplier relationship power, and switching costs. In a second book entitled *Competitive Advantage: Creating and Sustaining Superior Performance* [10], Porter suggested a framework to identify *where* value-added is generated in a firm, as a product is created and delivered.

Value-added from IT investments has also been stressed by Paul Strassman. Previously a senior information systems executive at Xerox Corp. and now a leading consultant, Strassman places an emphasis on the value that IT investments can create within a firm, but from a different perspective. He views IT investment as a component of overall "return on management capital." IT investment, measured as a percentage of overall management costs for a strategic business unit, is used in conjunction with measures of baseline organizational productivity. Strassman then proceeds to measure the incremental changes in management productivity which are associated with the IT investments. His "management productivity" approach is presented in a book entitled *Information Payoff* [12].

Robert Kaplan, an accounting professor at Harvard Business School and Carnegie Mellon University, and a noted critic of current management accounting methods, has also provided useful insights about how the intangible benefits of technology should be handled in cost-benefit analysis. He has argued that use of discounted cash flow (**DCF**) analysis can lead to underinvestment in computer-integrated manufacturing. In addition to tangible benefits such as savings on inventory, increased quality and reduced floor-space requirements, Kaplan pointed out the importance of considering intangible benefits:

> *Other benefits of computer-integrated manufacturing include increased flexibility, faster response to market shifts, and greatly reduced throughput and lead times. These benefits are much harder to quantify ... The difficulty arises in large part because these benefits represent revenue enhancements rather than cost savings.* [6]

Of course, Kaplan's comments apply equally well to non-manufacturing IT investments, where revenue enhancements are the new driving force for investment.

David P. Norton of Nolan, Norton and Co., the information systems consulting firm now owned by Peat Marwick, has suggested that the IT performance assessment problem should be recast to identify the "strategic interlock" between IT investments and the strategic goals of the firm [7]. Norton examined comparative measures across business units, such as IT investment per employee, in evaluating key strategic outputs -- return on assets, market share and profitability. To carry this one step further would require associating those levels of IT investment with circumstances under which the greatest strategic impacts are achieved. However, he offers no means for measuring the intangible benefits of the investment.

Another interesting approach was suggested by Marilyn Parker and Robert Benson in a recent cover story in *Datamation* [9], and a book entitled *Information Economics: Linking business Performance to Information Technology* [8]. The authors also claim that standard DCF and cost-benefit analysis do not capture

the full spectrum of value associated with IT investments. Instead, they describe other ways in which IT creates value, including value linking, value restructuring, value acceleration and innovation. Parker and Benson's approach to IT performance assessment is broadly based on microeconomics. IT investment represents an "input" to a production process within the firm, which is associated with an "output," such as cost reduction, or a cash or non-cash-generating benefit. The authors failed, however, to suggest a scientific means to evaluate evaluate IT investments to accompany their conceptual framework.

The most recent effort in this area is represented by a research project sponsored by the International Center for Information Technologies, which resulted in a book entitled *Measuring the Business Value of Information Technologies* [5]. A team of researchers, including Paul Berger, Robert J. Kauffman, Charles H. Kriebel, E. Burton Swanson and Paul Strassman, critiqued many of the well-known "input-oriented" measurement schemes, and presented a variety of views on how to supplement the information they provide with measures for the "business value" of IT outputs. Kauffman and Kriebel, in particular, suggested the use of management science methods such as Data Envelopment Analysis [1] to evaluate the contribution of IT to revenue generation and cost savings, and evaluate its business value linkages.

Outputs in 'Business Value Linkage' Impact Analysis

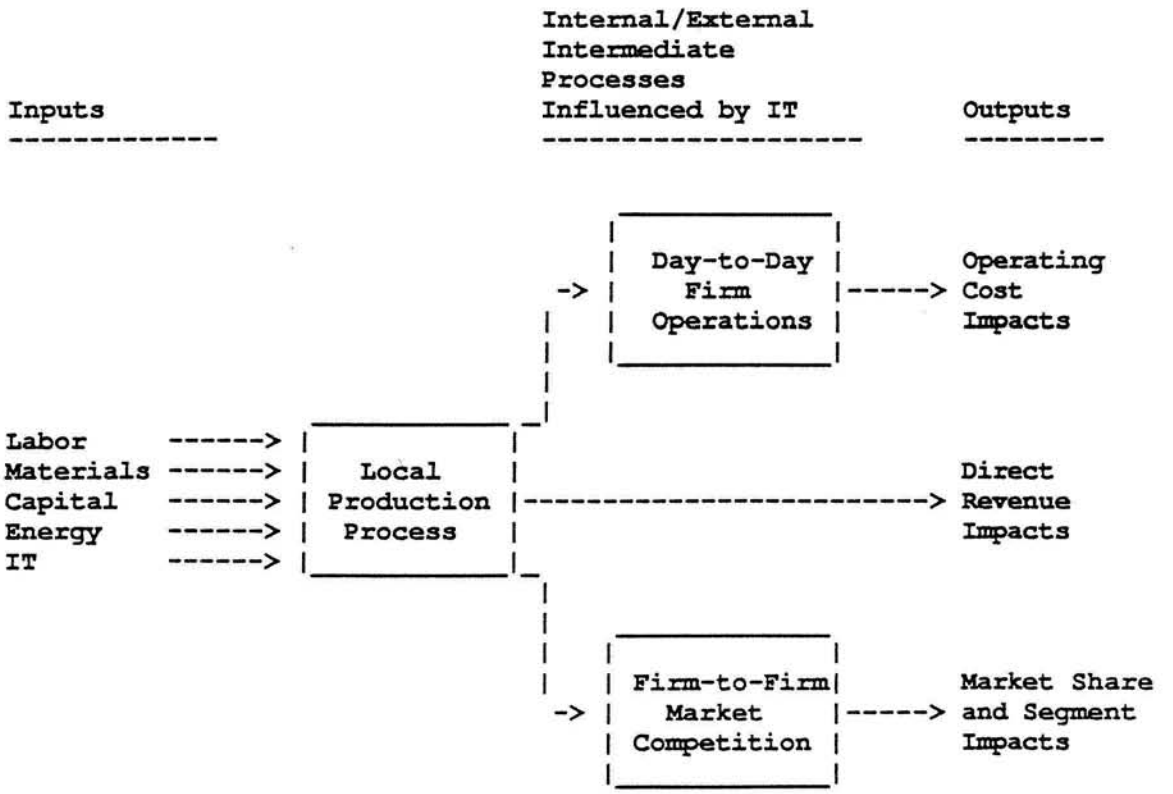
The objective of the new method -- 'business value linkage' impact analysis -- is to provide senior management with analytic tools appropriate to evaluating investments in a firm's IT infrastructure and individual IT projects. As we have seen, a common shortcoming of the methods suggested for identifying these impacts is that they lack a concrete mechanism for quantifying the *total value* of a specific IT investment. As such, there is no way to adequately determine the business value of, or return on, an IT investment.

Our approach builds on the efforts of Porter, who has provided a framework for managers to understand how value is created within a firm, and Strassman, whose work focuses on how IT can change management productivity in aggregate within a firm. We also build on the recent work of Paul Berger, a noted information systems consultant and past-president of the Society for Information Management. In a recent article entitled "Selecting Enterprise-Level Measures of IT Value" (in the ICIT book discussed above), Berger advocated the use of a simple framework to classify IT impacts into three groups: internal/operational, strategic/competitive, and product/service.

We propose the use of an approach which enables exhaustive identification of the potential business value impacts of IT. These links are formalized in a 'business value linkage' (**BVL**) defined by managers, that has several important features: an indication of the inputs (e.g., labor, materials, capital, energy and IT) employed in the local production environment, intermediate processes – inside or outside the firm -- influenced by IT, and the set of outputs modified by or attributable to the IT investment. Our approach also supports econometric estimation to identify and analyze evidence that links strategic benefits to an IT investment.

IT investments are characterized by three categories of impacts which provide a systematic framework for identifying the potential benefits: reductions in operating costs, direct revenue gains, and market segment and market share improvements. This characterization of IT impacts is a useful conceptual framework for IT managers because it identifies the ways in which IT ultimately impacts a firm's profit. Our framework also enables other aspects of business value such as business risk reduction and organizational learning to be taken into account through each of the prmary classes of impacts. A general representation of these business value impacts, which can be adapted by managers for use in many specific IT investment situations, is pictured in Figure 1 below.

Figure 1: A Business Value Linkage for Identifying IT Impacts



The three output categories also reflect the progressive difficulty managers experience when trying to justify IT investments, and they mesh well with Nolan's observation that as firms get more experienced, they tend to invest in IT projects that are more difficult to justify in terms of direct tangible benefits. In the

earliest phase of most corporate investments in IT, the primary justification is to reduce operating costs. Payroll and accounting system investments, often the first automation effort a firm undertakes, lead to the most obvious cost impacts. The easiest to measure impacts result from direct substitution of IT for other resources. More complex substitution of IT for operating resources, including change in the productivity of existing resource use, tends to result in harder to measure impacts. Following efficiency gains achieved via computerization, managers tend to look for ways to improve the firm's effectiveness. Investments are made in IT to achieve strategic goals, but it is even more difficult to identify the extent to which they are responsible, for example, for marginal increases in market share and other more diffuse benefits. Let's look at some concrete examples.

Operating Cost Impacts

The primary resources of interest for operating cost reductions, in addition to IT, are labor, materials, capital and energy. Financial services IT investments often promote savings in labor and capital, while manufacturing IT investments offer opportunities to cut waste in materials and energy, as well. The Mutual Benefit Life case we described at the outset provides a good example of baseline changes in a firm's efficiency, enabling it to provide more operating service for a proportionally smaller cost. American and United Airline's deployment of computerized reservation systems enabled these firms to save on reservation and sales labor, as travel agents answered their own inquiries on-line and booked tickets directly with a computer. Airline reservation system automation substitutes for the manpower needed to keep track of the many details related to ticket booking, load factors, and flight schedules. But, there is also an efficiency gain in the use of existing resources, as employees take less time per reservation transaction.

Girard Bank of Philadelphia, now a part of Mellon Bank, deployed ATMs in the 1970s with the intent of directly substituting machines for tellers. Girard even went so far as to charge a fee for bank customers who performed a transaction with a teller that could have been handled on an ATM. In the early 1980s, Irving Trust Co., a money center bank in New York City, spent heavily in PC-based delivery systems to assist corporate treasurers' funds transfer and cash management activities. This product, which Irving called "Ca$h Register," also provided customers with access to the bank's database of current and previous days' transactions and balance levels, which helped the bank to reduce inquiry servicing costs. More recently, Frito Lay invested in information systems to track product inventory levels in their delivery vans. This has resulted in improved utilization of resources via a better-coordinated distribution operation. Clearly, operating cost impacts are a crucial component of IT business value.

Direct Revenue Impacts

In some situations, business value from IT investments is created by direct revenue flows. Revenue impacts may occur which were not all initially envisioned when an IT investment was made to reduce operating costs. Later all the benefits must be considered as the IT is maintained or the investment is expanded. The use of CASE at First Boston is such an example. Licensing the CASE software and the

resulting trading/clearance system was secondary to the firm's initial interest in creating a competitive dealing infrastructure. A similar example is found in a treasury management IS product which competed with Irving's Ca$h Register, offered by Chemical Bank, New York. Initially, the bank built the Chemlink system to enhance its own banking and account services. Later, when it was recognized that a special combination of organizational ingredients was needed to create the software capability, the bank went on to license the system to banks overseas for fee income.

Airline reservation systems have also resulted in direct revenue flows, that were not the primary reason why the airlines initially deployed them. American and United charge travel agents network membership fees to these systems because access is now a competitive necessity for travel agents. According to Charles Wiseman, a professor and IS strategist at Columbia University, the Sabre/Apollo duopoly accounts for about 75-80% of all travel agency reservation system installations. ATM deployment also offers banks direct revenue opportunities, when their competitors' customers create a transaction at owned ATMs. These "interchange transactions" carry a fee that banks either assess one another or pass on to their customers. The firm owning the network receives membership fees from participating banks, and network-to-network switching fees. One example is the MAC network, owned by Philadelphia National Bank/Core States Financial. The *American Banker* newspaper recently reported that MAC handled about 7.9 million transactions per month during 1987.

Market Share and Market Segment Impacts

The final category of impact is most difficult to quantify before an investment is carried out, and even after it has had time to take effect. IT's influence in affecting a firm's competitive position is likely to be just one of a number of factors that lead affects market share. The challenge, of course, is to identify the extent to which the presence or absence of the technology affects the competitive balance after controlling for other factors. In the case of Otis Elevator, it is clear that the IT investment was a major force in shaping the firm's opportunities in the maintenance after-market. Investment in a centralized system to collect data about operations of prior installations improved Otis' effectiveness in an important market segment. Citibank's prowess in capturing retail deposit market share through ATM deployment is also a good example of a less easily quantified impact. It remains to be seen whether the recent concentrated deployment of "success machines" will be sufficient to help the bank to regain its advantage over the New York Cash Exchange network, which seems to have earned competitive parity.

Evaluation Methods for "Business Value Linkages"

In many firms, the extent to which some of the impacts we discussed above have actually been created is often in question. Without a means to quantify the less tangible impacts, managers often choose to leave them out of a cost-benefit analysis or a performance review. In other cases, managers may make seat-of-the-pants estimates that are not readily supported by the facts. Unfortunately, both can be misleading and may lead to inappropriate resource allocation. So, how can managers obtain evidence that their IT investments are creating business value? And, what means can be used to quantify that value in dollar terms?

Once business value outputs have been identified according to these categories, we suggest constructing simple and intuitive methods to determine how the business value varies with the independent IT design variables of the organization. This is a necessary step, because in conjunction with available statistical evidence, it formalizes the connection between an IT investment and business value outputs in the context of a firm. This approach is also of interest because it enables managers to quantify the marginal value of the impact of an IT investment in the firm's product delivery infrastructure.

With a data set suited to studying a specific IT's performance, econometric methods can test whether key variables influence the creation of a business value output. With three classes of business value outputs, however, a manager should also consider how the econometric models might be constructed to suit the circumstances in which business value is created by IT. In fact, this has been a major issue in our program of research. Some of the basic questions that need to be asked to construct a useful model for IT business value impact analysis are as follows:

- For what kind of impact is evidence required?
- What is the context in which the impact occurs?
- What other kinds of variables besides IT are responsible for the creation of the output?
- How will the variable(s) related to IT be represented in the model?

Explaining changes in operating efficiency related to IT deployment begins with the use of a reliable means of measurement for the level of efficiency during the period for which business value will be measured. Then, a model is developed which includes those factors most likely to *cause*, or explain, the variation in efficiency. When a number of different business units are compared -- for example, restaurants in a fast food chain -- efficiency can be estimated in terms of the set of factors likely to affect it, for sites at which a specific IT was or was not deployed. Banker and Morey [2] recently examined this kind of business value output using data obtained from 91 Hardee's fast food restaurants in southeastern states. The firm deployed "Positran", a computerized device attached to a cash register which cashiers use to record and transmit an order to the kitchen. Data Envelopment Analysis and other econometric methods were employed to identify that the impact on material wastage levels when Positran was used was significant only for smaller restaurants with more complex menus.

In other settings where labor usage is of interest, an econometric model can be developed to explain variations in labor usage efficiency. In the ATM example we will present in Part Two, bank branch tellers at Meridian Bancorp of Reading, Pennsylvania were shown to exhibit different levels of productivity in processing window transactions when an ATM was deployed at the branch. We also modeled the extent to which teller window transactions are diverted to ATMs, by examining branches with and without ATMs, and controlling for variations in service volumes and transaction types.

Forecasting methods seem more useful for identifying direct revenue impacts. Direct revenues from IT investments are easy to measure once they have occurred; instead, the difficulty lies in forecasting them before an investment has been made. Here, business value linkage impact analysis can be conducted using

sales forecasting models, with demographic factors describing a population of potential customers (individuals, small companies, large corporations, etc.), to estimate direct revenues. If sufficient data are available to planners, the sales forecasting models then can be adapted to identify the kinds of features an IT-based product must have to maximize profitability.

In order to identify market share and segment impacts, we employ econometric models which represent the competitive environment directly. IT can then be modeled as one of a set of features of an organization or site that may help to influence market share, in the presence of other competitors with different design features. Business value estimates of IT can be made by identifying the marginal contribution of the IT-related variables to explaining variation in market share. Econometric modeling provides the flexibility to explain resulting market equilibria, and describe changes to it. Since IT investments are likely to be secondary explanatory factors in predicting market share impacts, their significance and explanatory strength may not be very large. Sufficient care must be taken to capture the key variables affecting market equilibria. Consideration should be given to the likelihood that a time-lag exists between investment and impact, and that firms may invest heavily when they have had a very profitable year.

Conclusion

Identifying business value for each of the three categories of outputs described above requires an approach that will produce consistent results under a variety of circumstances. Previous methods have not always achieved this goal, leaving managers with a serious, unsolved problem in measuring the less tangible impacts. Business value linkage impact analysis is a step towards solving that problem, because it offers a way to identify and quantify IT outputs. The technique was designed to measure the wide range of IT outputs, including the *hard-to-quantify* impacts, so it meets the measurement problem head on.

In summary, business value linkage impact analysis involves three basic steps in order to evaluate business value impacts of IT:

1. Conceptualizing the business value linkage;
2. Collecting data and performing BVL impact analysis;
3. Translating the results of BVL impact analysis into business value estimates.

Performing an impact analysis guarantees results for managers. Identifying the different kinds of outputs which can result from an IT investment is a useful means to understand its potential to improve a firm's performance and competitive position. When IT is shown to have a significant influence in the creation of business value outputs, our approach provides a ready means to quantify those benefits. Often, it approach also identifies conditions under which specific IT investments have a greater impact. And, when no evidence is found to support the links from investment to impacts, a more "correct" cost-benefit equation comes into clearer focus. In many cases, knowing what the "right" outputs are is as important as knowing which ones to exclude.

In order to illustrate more concretely how to perform a BVL impact analysis, Part Two of this article will describe in detail how this series of steps was carried out to investigate the business value of ATMs for Meridian Bancorp. ATMs represent a particularly interesting kind of IT investment, because all three kinds of business value outputs are produced, and care must be taken to create realistic measures in order to capture them. This will also provide us with an opportunity to expand on our discussion of how to develop the necessary econometric methods, and evaluate the estimation results.

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