



Editorial—IT Investment Payoff in E-Business Environments: Research Issues

Rajiv Kohli

*Mendoza College of Business, University of Notre Dame,
Notre Dame, IN 46556, USA
E-mail: rkohli@nd.edu*

Susan A. Sherer

*College of Business and Economics, Lehigh University,
Bethlehem, PA 18015, USA
E-mail: sas6@lehigh.edu*

Ayelet Baron

*Worldwide Strategy and Planning, Worldwide Sales, Cisco
Systems, Inc., 170 West Tasman Dr., San Jose, CA 95134, USA
E-mail: ayelet@cisco.com*

Abstract. *E-business environments pose unique challenges to the measurement of information technology payoff. In this paper we discuss some of those challenges as stemming from issues such as the productivity paradox, level of measurement, choice of metrics and the process of measurement. Further, we discuss those characteristics that make investments in E-business environment different from other types of IT investment. In doing so, we draw upon the contribution of the papers in this special issue of Information Systems Frontiers and conclude with our proposal for areas where further research needs to be conducted.*

Key Words. *IT payoff, E-business environments, E-commerce, information technology productivity, information technology investment*

1. Introduction

Measuring payoff from information technology (IT) investments is a major issue for both information systems and business managers. Senior executives have long been concerned about whether they made the right IT investment decisions and whether proposed savings will materialize (Advisory Board Company, 1997). Today, as companies increasingly depend upon collaborative networks and information sharing, this concern has only increased as risk and rewards from IT investments in e-business environments can be substantial.

The issue has also garnered the attention of academics who have responded to the IT productivity paradox issue. Following a call for the need to develop metrics in e-business environments (Straub et al., 2002), we address the measurement of payoff from IT investment in this new environment.

2. IT Payoff

The importance of measuring the payoff from information technology investment has been well documented in past studies (Keen, 1980; Banker et al., 1993; Brynjolfsson and Yang, 1996; Barua and Mukhopadhyay, 2000; Mahmood and Mann, 2000). The increasing cost of technology in a more competitive marketplace has raised the stakes for organizations and placed the onus on IT managers to demonstrate value. Pressure from senior management is relentlessly high due to demands for greater accountability from corporate boards with the increased focus on improving productivity while reducing operating expenses. IT investment has to compete, as it should, with other investments such as those in marketing and operations. All of this adds up to the need for a rigorous, objective, and well-documented process to measure and show value of IT investment.

2.1. *IT productivity paradox*

As demands to demonstrate payoff have increased, there are rumors that IT leads to no improvement, or worse, decline in overall productivity. Economists have argued that for all the investment in IT, there has been very little evidence that real productivity has increased (Strassman, 1990; Atkinson and Court, 1998). Yet, a large number of studies find that IT does lead to organizational impacts (Kohli and Devaraj, 2003). In fact, a recent study implies that another kind of paradox may be in play resulting from insufficient investment spending in IT by businesses, despite that fact that IT has demonstrated value (Kraemer and Dedrick, 2001). Nevertheless, the findings of past studies have been less than unequivocal. Practitioners as well as researchers have wondered why the mixed results have occurred. What are the reasons for inconclusive outcomes from such large IT spending by capable organizations? Is IT not being targeted properly, or are we measuring the incorrect outcomes? More specifically, are the measurement tools appropriate? Or, are the expectations unrealistic? Do different business environments affect payoff metrics differently? Perhaps each of these issues, briefly described in the following sections, contributes to the past mixed results.

2.2. *Payoff level*

Investments in information technology may occur at the level of a project, firm, industry, or economy. Studies reporting a lack of productivity have generally been at the industry or the economy level. As we move down to the firm-level, studies generally demonstrate a payoff (Devaraj and Kohli, 2000), perhaps, because industry and economy level studies obtain data from secondary sources. Firm-level data generally has more detail and evidence of complementary investments, along with IT investment, can also be found.

2.3. *Payoff metrics*

Although IT investment is often expressed as an expense on corporate balance-sheets, the nature of IT investments vary dramatically. For instance, an investment in improved performance of a payroll information system is less likely to demonstrate an impact on the organization as compared to one that improves customer service, however modestly. Yet another type of investment that provides chargeable service to the customer is likely to demonstrate instant payoff, which can be traced directly to the profitability of the organization.

This brief and simple example raises two issues commonly experienced in past IT payoff studies. First, what is the purpose of IT investment and how can it be measured? Second, what is the lag between the investment and expected payoff?

In investigating the first question, IT payoff metrics are generally grouped into three broad categories: (1) Profitability, (2) Productivity, and (3) Consumer Value. Profitability measures the benefits appropriated by a firm that directly affect the bottom line. Profitability is improved by either increasing revenue or cutting costs. When IT helps in achieving either increased revenue or reduced cost, an improvement in profitability can be expected. Productivity measures, on the other hand, measure the benefits of IT in saving time, reducing defects or rework, and essentially producing more with a given set of resources. Consumer value results from IT's creation of benefits for the consumers, such as ease of executing a transaction, accessing personalized information, and the ability to alter services ordered. Although separate, these are related measures of IT's value and as a matter of fact, previous research indicates that while IT has increased productivity and created substantial value for consumers, these benefits have not resulted in supranormal business profitability (Hitt and Brynjolfsson, 1996). Metrics for other forms of IT payoff can result from areas such as risk mitigation resulting from investment in public relations informational websites or replacing IT assets that might cause adverse impacts (e.g. Y2K). Alignment with corporate management business objectives is still another indicator of whether or not IT is present at the strategic table—the more IT is viewed as being an enabler to the business by tracking its results to those of the company, the higher the payoff. Further, benefits may also occur in improved quality of the product, which, ironically, might reduce the revenue in the short run. In short, IT payoff metrics need to take into account the fact that IT investments can result in a variety of outcomes—some tangible, some intangible, and some unexpected.

2.4. *Measuring the payoff*

The measurement process of IT has come under scrutiny because often we fail to understand the ways in which IT leads to a payoff. Frequently IT is not aligned with the organization's overall business strategy. IT management, at times, drives projects for the enterprise instead of looking at how it can solve complex business issues—for example, by replacing legacy systems and creating end-to-end customer visibility for

the company, the payoff from IT would be substantial to the overall business processes. The tendency is to view IT as directly affecting the profitability of the organization, often as “overhead.” As discussed above, payoff manifests itself in various forms, each of which imposes a different set of measurement requirements.

Past studies measured IT payoff as ‘variance’ in the metrics before and after. This approach generally views the IT as a black box and expects it to create a positive difference or variance in the outcomes such as return on assets, profitability, customer satisfaction, etc. Another approach called the process-oriented approach assesses the payoff by examining how the investment is made and events that lead to changes in the outcome variables. This process-oriented approach considers events that lead to the creation of IT assets, the events that translate IT assets to IT impacts, and, finally, the events that convert IT impacts to organizational performance (Soh and Markus, 1995).

Given that the process approach attempts to open up the black box of IT payoff, it also focuses on changes that facilitate the payoff. In doing so, the role of complementary changes in yielding the IT payoff becomes of interest to researchers. For instance, management’s role in creating appropriate assets such as trained professionals, support infrastructure and appropriate reward mechanisms, aid in the successful deployment of IT. Conversely, the process-oriented approach can also identify risks or failure points that affect payoff. Identifying and effectively managing such risks insures that IT assets lead to expected impacts.

Assuming that the IT is deployed appropriately using a successful, clearly identified deployment process, how can IT effects on the outcomes be isolated from other investments? A well planned research design and rigorous analytical techniques are needed to ensure that the impact of IT investments is accurately appropriated while accounting for other benefits from investments. This is easier said than done. Recent research indicates that it is the IT alignment and complementarities with other investments that leads to successful impacts. In other words, the synergy created by IT and other investments leads to increased competitiveness of an organization. Too often, IT is asked by the business to create tools without having the right business process in place. Automating bad processes never leads to IT payoff. By definition, IT’s roles in the synergy cannot be isolated. However, it is possible to examine the impact due to IT alone, followed by IT combined with one or more complementary changes. Devaraj and Kohli (2000) found

that IT investment led to modest improvements in quality and revenue. However, when the impact of business process redesign (BPR) was combined with IT investment, the IT impact was more pronounced.

The role of control variables in establishing validity of findings has also been discussed in the literature (Kohli and Devaraj, 2003). Control variables account for other business and economic conditions that might otherwise interfere with the true impact of IT on business outcomes. For instance the competitive space within which the firm operates will affect how the IT pays off. Similarly, the general state of the economy will be a factor in overall firm performance and should be accounted for accordingly when examining the IT payoff. Other control variables in larger firm-level studies may account for firm size, and type of investment, such as operational, managerial or strategic, and sales.

3. *Are E-Business Environments Unique?*

E-business has many connotations. To some organizations it implies establishing an electronic channel to its customers, or suppliers or both. IBM’s Advanced Business Institute defines E-business as

“an organizational strategy linking IT and the World Wide Web to create strategic advantage through operational efficiency, customer relationships, innovative products and services, and speed.” (Brier, 2002)

Note that e-business is defined as an organizational ‘strategy’ as opposed to a specific hardware or software. Today, companies increasingly join networks of suppliers, customers, and even competitors to generate e-business value. Sometimes, e-business payoff to a firm is dependent upon investments made by customer or supplier organizations. In other words, an organization could be involved in e-business without making an investment as long as it is part of the strategy to create strategic advantage resulting from linking its IT to other firms using, for example, the World Wide Web.

A practical example is Cisco Systems, which believes that investments in IT help companies reduce costs, improve productivity and profitability, and increase customer satisfaction. As part of its strategic plan, Cisco is leveraging the Internet and e-business to increase its own productivity and competitive advantage. During FY2001, Cisco realized productivity gains of approximately \$2 billion from continued development and investment in Internet business solutions such

as customer care, workforce optimization, supply chain management, and e-learning.

Should measurement of IT payoff differ in E-business environments? There are a variety of views on whether e-business imposes special measurement needs. Some argue that e-businesses are no different than other forms of IT, only a different type of asset. Others indicate that the metrics of e-businesses are evolving as is the nature of its business enablement. Recently, two special issues of *Information Systems Research* on ecommerce metrics placed the spotlight on the need for identifying metrics of electronic commerce (Straub et al., 2002). Clearly, e-business environments have redefined the way organizations conduct their operations. For instance, continuous planning, forecasting and replenishment (CPFR) systems enhance collaboration among trading partners that can create payoff for all parties. Therefore, it is argued, e-business environments should be given special consideration in measuring investment (Barua and Mukhopadhyay, 2000).

Investment in E-business environments (EBE) can be considered distinct from traditional IT investments for various reasons that all have one underlying theme: EBE investments pose greater risks as well as rewards compared to most traditional IT investments. It should be recognized that most EBE characteristics can be found in traditional IT investments as well. However, these characteristics tend to be pronounced in EBE.

First, EBE have generally been more volatile and therefore prone to greater risk. Therefore, the IT investment should be the result of a well-planned strategy and closely monitored, even more so than other investments. Likewise, EBE offers extraordinary opportunities that, when managed appropriately, can yield significant gains as well as long-term competitive advantage.

Second, by nature EBE applications are cross-functional and span traditional departmental boundaries. Thus, greater numbers of applications within a firm can receive and provide information to EBE applications. This is in contrast to information systems generally designed for a specific application and interfaced with other applications as and when needed. This cross-functional nature can facilitate timely data sharing and at the same time heighten security risks. Cross functionality in EBE is not limited to internal applications and generally extends to suppliers and customers across the value chain. In such cases the investment-payoff relationship may be blurred because the firm making the investment may not necessarily be the one getting the payoff. Again, this can be seen as a risk

as well as an opportunity affecting IT payoff in ways never experienced. Finally, the customer relationship in e-business is extremely critical. If the customer's culture is very different from the business' culture, there may be high risk in achieving payoff. Customer Relationship Management programs need to be designed to improve the quality of core customer information to make critical customer data addressable, accessible, and unambiguous enterprise-wide.

Third, the technology in EBE is evolving. Often the EBE is built with components developed by an assortment of developers. Creation of appropriate IT assets can be a challenge. However, when successfully created, these assets can yield significant impacts such as the creation of new products and services. For instance, EBE include online shopping marts created by one set of developers, security provided by another firm, with credit authorization or guarantee by yet another financial institution. If a firm can make this integration happen smoothly, there is an opportunity to provide a complete range of electronic trading services to businesses.

More recently, the perceptions of EBE business payoff, commonly referred to as the dot.com boom/bust, obscured real business value. While not long ago anything dot.com was perceived to be high payoff, the view has reversed. Such diversity of perception can affect the investment as well as the expectation of payoff. In part due to the recent downturn, many EBE projects were scaled back or eliminated, making it harder to assess the real payoff.

Finally, using past payoff measures to make EBE investment decisions itself is a challenge. Resource deployment for EBE may be at the expense of traditional IT investment. Yet, the EBE payoff metrics are in their infancy and could take several years to establish (Straub et al., 2002). For investment decisions that rely on future opportunities, the traditional economic justification tools such as discounted cash flow (DCF) are considered to be blunt. Recent approaches such as real options are considered more appropriate for identifying potential payoff from EBE investments (Benaroch and Kauffman, 1999, 2000).

4. Issues in Measuring Payoff in E-Business Environments

The papers in this special issue address many of the specific issues in IT payoff that are particularly significant in e-business environments. These include the

selection of appropriate payoff metrics, including payoff to multiple parties, the impact of market risk on investment decisions, coordination of multiple components in the development of an e-business infrastructure, and finally, the impact of complementary changes in the process of investment.

4.1. The metrics: Measuring payoff in e-business investments

As we have noted, multiple IT payoff metrics have been used, often with different results. Determining the appropriate variables in IT payoff has been problematic. This issue is exacerbated in EBEs that are deployed across multiple platforms, projects, vendors, and partners. The first paper in this special issue provides a historical analysis of problems with payoff measures. Kleist demonstrates that technology often determined the choice of the dependent variable; for example, end user satisfaction in the PC computing era; competitive advantage in the strategic era, and now web usage and page views in e-business environments. She argues that this leads to construct validity problems. While both qualitative and quantitative dependent variables have been used to measure IT payoff, qualitative measures lack rigor and quantitative measures lead to only the most obvious of IT investments. This has led to a gap that has encouraged poor investment decisions.

Kleist proposes divorcing the dependent metrics from the technology, blending traditional qualitative and quantitative measures of implementation success with new measures based on production theory. The dependent variable in production theory is the volume of e-business good delivered. She suggests that production theory concepts such as the production possibilities frontier, isoquant curves of inputs to production, long run cost curves of IT capital and demand curves for different e-business technologies can support the following e-business decisions: determine whether e-business investment is warranted, allocate capital expenditures to IT projects vs. alternative types of expenditures, determine optimal levels of e-business deployment, and analyze the elasticity of demand for different IT products.

Kleist recognizes that measuring payoff is more difficult in EBE because applications cut across boundaries, affecting multiple parties. In e-business applications, research needs to consider payoff to more than one party and determine how to relate these payoffs to each other to measure the joint payoff from the application. Participating companies need to share

information and payoff depends upon relationships between participants.

The second paper by Lu specifically addresses the need to assess payoff from multiple perspectives. Lu considers payoff from the perspective of both suppliers and customers of an e-commerce web application. She tests several hypotheses about the relationships among payoff measures perceived by both customers and web site owners, along with aspects of the e-commerce application itself. She reports that benefits from an e-commerce application are fully dependent on or related to improved relationships with customers. Ecommerce payoff to a company is measured in terms of enhancing company image and gaining competitive advantage. Customer satisfaction not only influences payoff from the e-commerce application but is an important measure of application success. Customer satisfaction depends upon the cost spent on maintenance of the system. The main contribution of Lu's paper is the consideration of payoff to multiple parties. We need to extend this research to multiple companies that are investing in joint systems and look at measuring the payoff to all participating companies and relationships between payoffs to each participant.

While Lu's paper focuses on payoff to individual parties in an e-commerce transaction, Kamssu, Reithel, and Ziegelmayr offer stock performance as a payoff metric. They argue that the choice of technology impacts stock returns. Using a unique period in history, they show that during the booming economy of the late 1990s, Internet use was highly valued by stockholders. Internet-dependent firms had lower excess returns than non-Internet firms, because stocks of companies dependent upon the Internet traded at relatively higher prices than non-Internet stocks. However, the potential for the use of this metric for evaluation of IT payoff may be transitory. Kamssu et al. show that after the crash of internet-based business stocks in the year 2000, there was a decrease in the significance of the variable—use of the Internet—on stock performance. Yet, if future new e-business applications and/or technologies can create the excitement and attention of stockholders, this approach to measuring IT payoff may again prove fruitful.

4.2. The environment: Market risk

As Kamssu et al. have shown, business and economic conditions can affect IT's impact. Business/economy risks are exacerbated in EBE. Risks in development

and use can alter the payoff from an investment; yet the payoff and risk literature have not been well integrated (Kohli and Sherer, 2002). Moreover, the risk literature typically focuses on project specific risks. The paper by Dos Santos focuses on the impact of market risk on key IT investment decisions often addressed in e-business environments including outsourcing, interorganizational systems, and service levels. Market risks are risks to a project's payoff resulting from adverse movements in the volatility of markets rather than project and firm specific risks. These risks affect the costs and benefits of all projects. In today's volatile economy they are increasingly significant, as returns on recently completed IT investments have been negatively affected by the downturn in the economy.

Dos Santos focuses on several decisions that are very critical in today's e-business environments. Increasingly firms are seeking to outsource their services. Using contemporary finance theory, Dos Santos provides an explanation for this phenomenon, demonstrating that firms are more likely to outsource when the market risk of demand for operations increases. In-house operations have greater market risk because they have larger fixed cost components that cause cash flows to be more sensitive to economic conditions. In e-business environments, firms are increasingly investing in interorganizational information systems that link customers and suppliers. Dos Santos demonstrates how market risk affects that payoff from such systems. He shows that the value of an interorganizational system decreases as the market risk of its benefits increases while its value decreases as the market risk of costs increases. Managers can use this information to determine how they should pay for these systems and how they should be compensated for their use. Fixed periodic payments and fees based upon use can alter the market risk of costs and benefits and thus the value of the investment. In today's e-business environments, IT services including education, training, hardware maintenance and software support are critical. Dos Santos shows that higher service levels should be provided as demand risk decreases, market risk of benefits decreases, or market risk of cost increases. This information can help managers determine optimal service levels and service contracts.

The payoff from any IT investment is affected by many different risks. Dos Santos shows how incorporation of the effect of market risk on payoff can be used to help managers make more effective decisions.

4.3. The technological infrastructure: Using components to build e-business applications

Today in EBE companies often build applications from a variety of components. No longer are large legacy systems or monolithic applications the norm. To develop their e-business applications, many companies bring together "best-of-breed" components from customer relationship management, ERP, selling chain management, supply chain management, and e-procurement applications. These components, generally packaged applications, must be able to inter-operate. Thus payoff from these systems is a function of the difficulty and value of inter-component integration and compatibility. Sarkis and Sandarraj introduce a multistage multi-attribute decision model, consisting of the Analytical Hierarchy Process (AHP) model and the Supermatrix approach to evaluate the intangibles involved in developing componentized enterprise integration technologies (EITs). They evaluate componentized EIT from multiple perspectives and consider a number of intangible factors. In their example, they use the AHP to weight component intra-functional factors such as adaptability, openness, scalability, security, reliability, ease of use, support, and perceived value. The Supermatrix approach is then used to evaluate the compatibility of components. An overall benefit/cost ratio is determined for different combinations of components. This can help IT managers determine the best combinations of components for their e-business applications.

4.4. The investment process: Complementary changes to achieve payoff

After analyzing how e-business changes the environment for IT projects, the relationships between organizations using the applications, and the architecture of the applications itself, this special issue turns to the process of achieving payoff from IT applications. The paper by Sherer, Kohli, and Baron addresses the complementary organizational changes that take place when implementing an e-business application in order to achieve payoff. This paper provides a framework for assessing the impact of change management on IT investment payoff. In particular, the authors present a case study at Cisco Systems in which specific organizational change management initiatives were implemented during a major software upgrade. They describe how to measure the impact of these initiatives on organizational change and payoff from the investment. The authors report that planned communications and organizational change management strategies contribute to

payoff from IT investment, measured in terms of client satisfaction with the process and system and reduced cost and time to upgrade all systems.

5. Future Research

We believe that there are excellent opportunities for future research in measuring IT payoff in e-business environments related to the four general themes: metrics, environment, technological infrastructure, and process.

5.1. Metrics

What are the appropriate metrics in e-business environments? While several of the papers included here discuss some alternative metrics and the need to measure payoff from multiple perspectives, we believe that there is a need for work that considers joint payoff from efforts of multiple parties who collaborate in e-business environments. Individual company profitability and/or productivity may not capture the overall impact of investments. Moreover, the impact of investments on multiple parties may occur during different time periods. For example, when retailers and manufacturers join together to utilize collaborative, planning, forecasting, and replenishment systems, overall supply chain efficiency can be improved. What metrics can be used to measure the joint efficiency of the supply chain?

Customer metrics, in particular, are very important in EBEs. This environment changes the relationships with customers. How do we measure IT's facilitation of better customer engagements. How do we update these relationships and metrics as the technology changes?

5.2. Environment

Many e-business investments involve parties from different cultures. We need research that captures inter-cultural perspectives. For instance, in some cultures, business is not effectively conducted until parties have met face to face and established personal familiarity. How do EBE impact the parties' interaction and how does this cultural trait affect the design of EBE applications? Cultural norms can also affect the development of IT projects, parts of which may be developed in different continents. While EBE have greatly facilitated cross-continent software development teams, cultural differences have impeded extracting their full potential. In our discussion with a US-based project software development manager, we found that her greatest

challenge was to ensure that developers in various parts of the world understood that a deadline on the project is truly a deadline. For instances, in some cultures a deadline date may mean a date that one aims for, but does not necessarily deliver on.

IT in EBE applications poses greater security risks to data as well as systems than in traditional environments. Partly because electronic processes replace previously human-intensive processes, EBE systems are likely to be compromised if robust security is not implemented. Further, because EBE often involve extending a firm's IT infrastructure beyond its boundaries, the data are prone to misappropriation, alteration or loss. Therefore, EBE have to work harder to ensure physical security of the IT infrastructure as well as design contracts with partners that would ensure the security and integrity of data.

5.3. Technology

EBE impose special requirements of computing as well as telecommunication technologies. As applications grow, the demand for faster equipment as well as transmission of voice, data and video will grow. However, recent trends have indicated that while telecommunication capacity has grown significantly, the applications have not been developed fast enough. Although some of the disparity between the technology and applications has been a function of faltering economic conditions, the fact remains that benefits of EBE are yet to be fully exploited for advanced technologies for B2B and B2C, including mobile computing, wireless internet applications, and satellite tracking systems.

5.4. Process

E-business investments involve changes to business processes that cut across business functions and entities. Complementary investments in change management are required to change business practices. Incentives need to be provided to encourage collaborative behavior. Risks in the development and implementation process can alter the impact of IT investments. The process of investment by multiple parties in e-business opportunities must be understood. Risks must be clearly identified and measured, and the impact of risk on payoff must be considered. Customer behaviors often have to change because e-business alters customer relationships. What processes are needed to help foster these changes? Research that focuses on new processes across multiple entities from customers

to suppliers as well as IT's overall alignment with the organization's business goals is clearly desirable.

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Rajiv Kohli is an assistant professor in the Mendoza College of Business at the University of Notre Dame. He was recently an internal Consultant and Project Leader—Decision Support Services at the corporate office of Trinity Health in South Bend. Dr. Kohli received his PhD from the University of Maryland, Baltimore County. He has taught at Lehigh University, University of Maryland College Park, and University of Maryland University College where he was awarded the Teaching Recognition Award. Dr. Kohli has worked and consulted with MCI Telecommunications, Westinghouse Electronics, and Rohbe Corporation in addition to several healthcare organizations. Dr. Kohli's research is published or forthcoming in *Information Systems Research*, *Communications of the ACM*, *Journal of Management Information Systems*, *Decision Support Systems*, and *Information & Management* among other journals. He is also a co-author of the book *The IT Payoff: Measuring the Business Value of Information Technology Investments* (Financial Times Prentice Hall, 2002). Dr. Kohli's research interests include Organizational Impacts of Information Systems, Process Innovation, and Enhanced Decision Support Systems.

Susan A. Sherer is the Kenan Professor of Information Technology Management and Program Director of Information Systems at Lehigh University. Sherer received a Ph.D. in decision sciences from the Wharton School of the University of Pennsylvania, M.S. in operations research from University of Pennsylvania, M.S. in industrial engineering from State University of New York at Buffalo, and B.S. in mathematics from State University of New York at Albany. Prior to moving into academia, Dr. Sherer managed projects for several manufacturing companies including Leeds & Northrup Company and Union Carbide Corporation. Sherer's research interests include software failure risk, managing information systems risks, inter-organizational information systems, and IT benefit justification. Sherer is the author of *Software Failure Risk: Measurement and Management* (Plenum Press 1992), as well as numerous articles that have appeared in *Journal of Systems and Software*, *Software Maintenance*, *Software Engineering Journal*, *IEEE Software*, *Information and Management*, *Journal of Information Systems*, *International*

Journal of Electronic Commerce, Communications of AIS, and Journal of Electronic Commerce Research.

Ayelet Baron is an expert in global business strategy and organizational change management. In her current role at Cisco Systems, Inc., she is responsible for facilitating the Worldwide Sales organization's strategy and business planning. Working for Cisco's CIO, she previously established and led the Organizational Change Management department at Cisco's IT, where she was responsible for key change initiatives ranging from an IT portal to moving IT from order takers to trusted advisors and business partners. During her career she has built leading edge teams, worked in diverse market segments and developed a reputation as a highly creative change-agent. Prior to Cisco, Ayelet spent 16 years as a consultant managing the development, implementation and measurement of key initiatives and programs

for clients embarking on major change initiatives including mergers and acquisitions, technology implementation, new leadership, cost reduction initiatives, and organizational realignments for global Fortune 500 companies. She is a recognized industry leader and speaker on change management, strategic communication planning, new technologies and business strategy. She was on the executive board of the Strategic Leadership Forum, International Director-at Large for the International Association of Business Communicators (IABC) and past president, Toronto chapter, IABC. Her articles are published in *Communication World*, *Strategic Communication Management* and *Across the Board*. She is quoted in *HR Executive*, *Journal of Employee Communication Management* and *Communication World*. She is currently working on a book about how to implement effective business strategies in today's changing world.