REALIZING THE BUSINESS VALUE OF INFORMATION TECHNOLOGY INVESTMENTS: AN ORGANIZATIONAL PROCESS[1]

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Executive Summary

A primary reason businesses fail to realize intended payoffs from their information technology (IT) investments is their lack of an effective process for planning, implementing, evaluating, and institutionalizing the payoffs. We present a framework to conceive and implement an IT investment's payoffs, ensure creation of the appropriate assets needed to achieve the payoffs, and measure the actual outcomes. The four phases in the AIAC framework are Alignment, Involvement, Analysis, and Communication.

In examining the business value of IT through this framework, we present three central themes in this paper:

1. *IT payoffs are the responsibility of the entire organization, not just the IT department.*

2. *Management of IT payoffs begins prior to the investment and continues through post-implementation.*

3. *IT payoffs are contingent upon creating and exploiting complementary assets.*

We illustrate an organizational process for managing IT investments and measuring the business value of those investments by drawing on the experiences of Holy Cross Health System, a multi-entity healthcare organization that invested in a corporate-wide cost information system (CIS) and established a mechanism to extract business value from that investment.

WHY MEASURE THE BUSINESS VALUE OF IT?

Worldwide spending on information technology (IT) in 2003-04 is estimated to grow in every major segment of the economy.[2] The US financial services sector, which accounts for a large part of US IT spending, is projected to increase spending by about 15% by 2005.[3] Similarly, the US government budget for 2003 anticipated $50 billion in IT spending, an increase of 11% over the previous year, even though other spending had slowed.[4]

These estimates of investment indicate that IT continues to be regarded as a critical resource that leads to organizational value. However, this assumption has not always been shared by functional business managers. CIO's often complain that IT is not given the opportunity to shape business strategy. For their part, business managers – CEO, COO and CFO – charge that IT managers do not always understand the nature of the business and, instead, focus more on the technology. The reality is that payoffs from IT investments are not just the responsibility of the IT function. Each constituent who uses IT or is involved in the
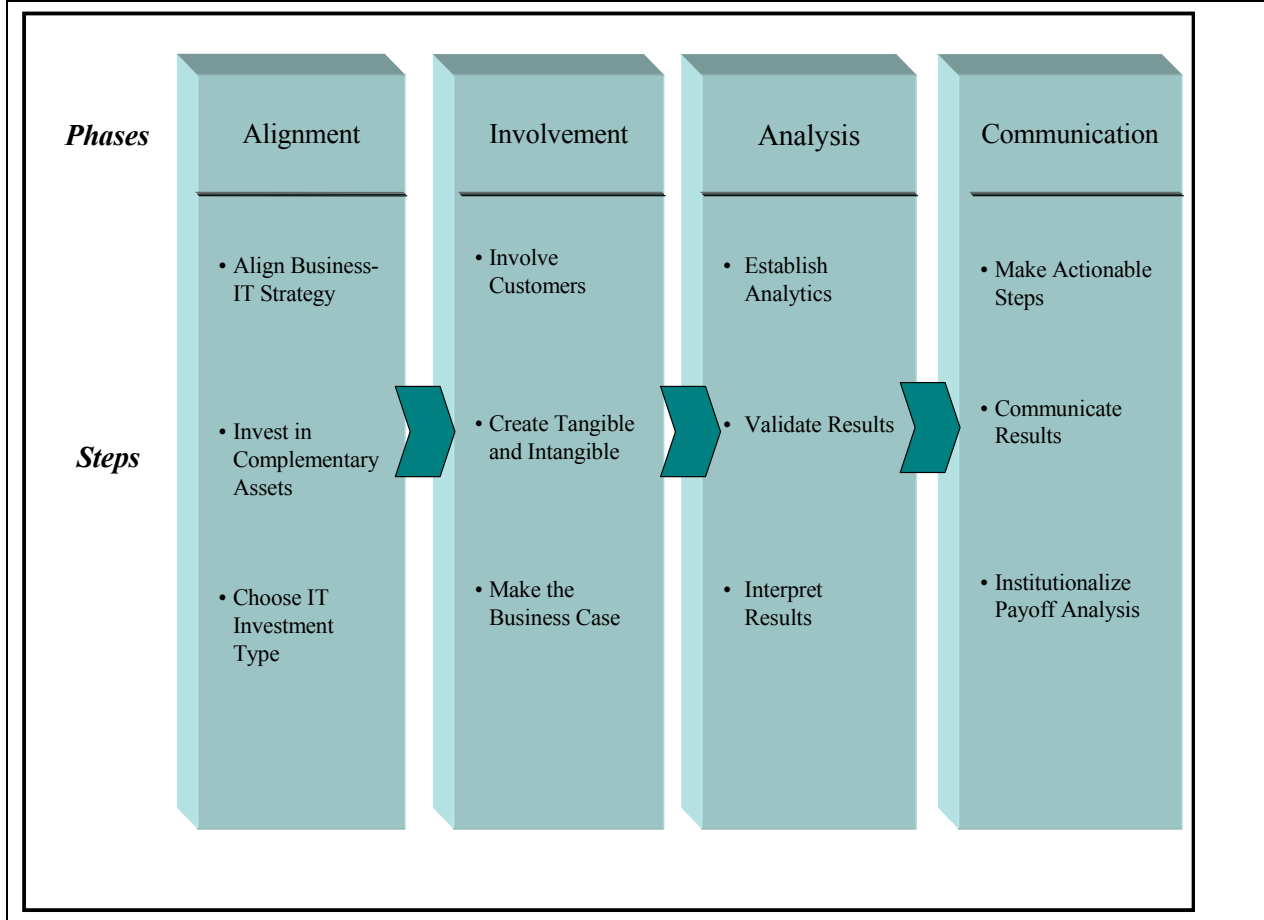
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[1] Mike Vitale was the accepting Senior Editor for this article.
[2] "Gartner Dataquest Says 14 Vertical Markets to Increase IT Spending in 2003" http://www4.gartner.com/5_about/press_releases/pr21jan2003a.jsp.
[3] The Financial Services Fact Book http://www.financialservicesfacts.org/financial2/technology/it/ provides a categorization of IT spending in banking, insurance, and securities services.

[4] Gilbert, A. "Bush budget proposes hefty IT increase," *CNET news.com*, 2002, http://news.com.com/2100-1001-830196.html.

Figure 1: Phases and steps in the AIAC framework for measuring IT Payoff (Adapted from Devaraj and Kohli, 2002)

Phases	Alignment	Involvement	Analysis	Communication
Steps	• Align Business-IT Strategy	• Involve Customers	• Establish Analytics	• Make Actionable Steps
	• Invest in Complementary Assets	• Create Tangible and Intangible	• Validate Results	• Communicate Results
	• Choose IT Investment Type	• Make the Business Case	• Interpret Results	• Institutionalize Payoff Analysis

value generation shares responsibility for aligning IT with business functions.

Nevertheless, measuring the business value of IT remains a resource-intensive, yet desirable, goal. In a recent survey, 86% of the information systems professionals felt that measuring IT value was an important or an extremely important priority. Yet only 10% felt that the value measures were very reliable or highly reliable. Furthermore, the survey indicated that less than 15% of the companies conducted post-implementation measurement of IT business value.[5] Measurement of IT entails a broad time frame, beginning at pre-investment strategy formulation and continuing well after the investment is made.

Realizing value also requires additional investments or process changes, such as training, process redesign, and skilled people, to complement the IT investment.

Lack of clear responsibility, inaccurate measurement, and misplaced investment, when combined with skepticism over the value of IT, can lead to frustration and finger pointing when the expected payoffs are not realized.

The Benefits Of A Measurement Process

A well-organized IT payoff measurement system serves as a mechanism for monitoring and insuring "the conversion effectiveness" of IT assets into business results.[6] A measurement system assists managers in capitalizing on organizational resources, creating an IT measurement process, and taking corrective action when an IT investment does not yield the expected payoffs.

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[5] Gliedman, C. "Measure Business Value Created by IT Spending to Fight Perceptions of Little Benefit," 2000, http://www.microsoft.com/business/articles/value/valgiga.asp.

[6] Weill, P. The Relationship between Investment in Information Technology and Firm Performance: A Study of the Valve Manufacturing Sector, *Information Systems Research*, 3, 4 (1992), 307-333, defines conversion effectiveness.

Figure 2: Key Personnel, Resources Required, and Expected Outcomes in the Four Phases of the AIAC Framework

	Alignment	Involvement	Analysis	Communication
Who should be involved?	• Board of directors • C-Level executives • External consultants	• Chief Technology Officer • Business process owners • External and internal customers	• IT department • Hybrid managers • External consultants • Financial analysts	• Top management • IT department • Business unit managers • Office of Project Management
Resources required	• Market intelligence • Business forecast • Current strategic plan	• Coordination expertise • Business domain experts • Technology experts • Forum to get business and IT experts together	• Statistical and analytical expertise • Representative business scenarios • Data mining of historical data	• Web development • Project management • Writing and communication expertise • Attendance at user-group meetings
Outputs expected	• Aligned IT-business strategy document to serve as a roadmap for milestones, timelines, constituencies involved • Decision to invest in strategic technologies such as corporate-wide ERP or mobile commerce	• Needs assessment document • Buy-in and support from process owners • IT assets created	• A business case and technical report outlining the findings of the analyses in practical terms • IT use that leads to tangible and intangible payoffs • IT impacts on the organization • Assumptions, limitations, and generalizability of the analyses	• Press releases • Town hall meetings • White paper on IT impact on department as well as organizational processes • IT payoff as a managerial dashboard indicator • Organizational learning for future IT projects

An organized measurement process to demonstrate the business value of IT addresses the demands for greater accountability as the size of IT investments increases and as other business functions compete for a piece of the total investment pie.

Being able to extract business value from IT investments also demonstrates to stakeholders an important knowledge asset. Prerequisites include complementary investments and changes, such as effective manage-ment roles and processes.[7] IT investments can be viewed as seeds and complementary investments viewed as the nourishment necessary for the investments to yield the expected payoffs. A recent study suggests that each $1 invested in IT may require as much as $5 in complementary investments to yield

[7] Sambamurthy, V., and Zmud, R.W. "Arrangements for information technology governance: A theory of multiple contingencies," *MIS Quarterly* (23:2), June 1999, pp 261-290.

Holy Cross Health System (HCHS) Invests in a Cost Information System

Holy Cross Health System (HCHS) is a national network of hospitals across the United States. The member hospitals have combined beds of over 4000, employ about 20,000 people, and have total operating revenues of approximately $1.5 billion. Many HCHS hospitals have been providing healthcare for over 100 years. The hospitals provide a range of services, including acute care, extended care, residential facilities for the disabled and elderly, and occupational medicine.

The Business Challenge Was to Calculate Costs

In the 1990s, many hospitals suffered financial losses from increased costs and decreased reimbursement for services. HCHS hospitals faced such conditions and their profitability depended upon how well they could align their costs with expected reimbursements, either by reducing costs or by negotiating financially favorable insurance contracts, or both.

Hospital administrators know what they charge for patient services, but they usually do not know how to determine the actual cost of a service or procedure. Traditionally, hospitals have calculated costs based on the cost-to-charges ratio, where total costs are divided by total charges (revenue) and the resulting ratio is applied to each service. As a result, a large portion of costs are fixed costs and remain outside the managers' control. Furthermore, when the cost of a procedure is uncertain, hospitals have difficulty assessing whether or not an insurance contract will result in a profit or a loss.

The Solution Was a Cost Information System

HCHS determined that to exercise better control over its operations, such as cost reduction and process redesign, it had to develop a reliable cost information system (CIS). The CIS would be integrated with, among others, the general ledger for expenses, the order entry systems for resources consumed, and the human resources systems for labor costs. In addition, the business managers would set productivity benchmarks to calculate labor costs. Depending upon the resources consumed, costs would be allocated to each procedure. These costs would be applied to each patient's medical record and used by the decision support system (DSS) in various analyses.

Similar challenges of cost containment and control over operations are being experienced by automobile companies, electronics manufacturers, and financial services companies because competitive pressures have necessitated cost cutting and process redesign.

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successful payoff.[8] Organizations that fail to make these complementary investments can put their IT payoffs in jeopardy.

THE AIAC FRAMEWORK FOR MEASURING IT PAYOFFS

Despite targeted investments in IT and performance measurement systems, IT investments often fail to demonstrate benefits because the measurement process is weak. A robust measurement process addresses the shortfalls noted above.

The AIAC framework is a robust process with four phases—Alignment, Involvement, Analysis and Communication—as shown in Figure 1.[9] The feedback loop at the end of each phase provides learning and refinement of the IT implementation and payoff process.

1. In the *alignment* phase, all technology investments undergo a critical review of the fit between the business strategy and the IT investment in supporting that strategy.

2. In the *involvement* phase, the customers or users of the IT investment are engaged in the payoff process and in selecting the appropriate metrics to gauge payoff.

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[8] Brynjolfsson, E., and Hitt, L.M., "Beyond computation: Information technology, organizational transformation and business performance," *Journal of Economic Perspectives* (14:4) 2000, pp 23-48.

[9] Devaraj, S. and R. Kohli, *The IT Payoff: Measuring Business Value of Information Technology Investment*, Financial Times Prentice Hall, Upper Saddle River: NJ, 2002.

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3. In the *analysis* phase, the actual payoff is assessed. Unfortunately, many IT payoff projects conclude at this point and do not learn from the experience.

4. In the *communication* phase, the findings of the analysis are disseminated in a meaningful and useable form to promote learning and improvements in achieving paybacks.

Figure 2 answers the following questions about each phase of the framework:

1. Who should be involved in this phase?

2. What resources are required to successfully implement this phase?

3. What outputs can be expected from this phase?

This snapshot of responsibilities, resources, and expected outcomes can help managers plan and foresee the results of each phase, and it can be used as a communication tool to gain buy-in from those who will be involved or will provide resources or benefit from the investment.

To discuss the strategies for accomplishing the goals of each AIAC phase, we use the journey of Holy Cross Health System in investing in a cost information system and establishing mechanisms to ensure continued payoffs from that investment.
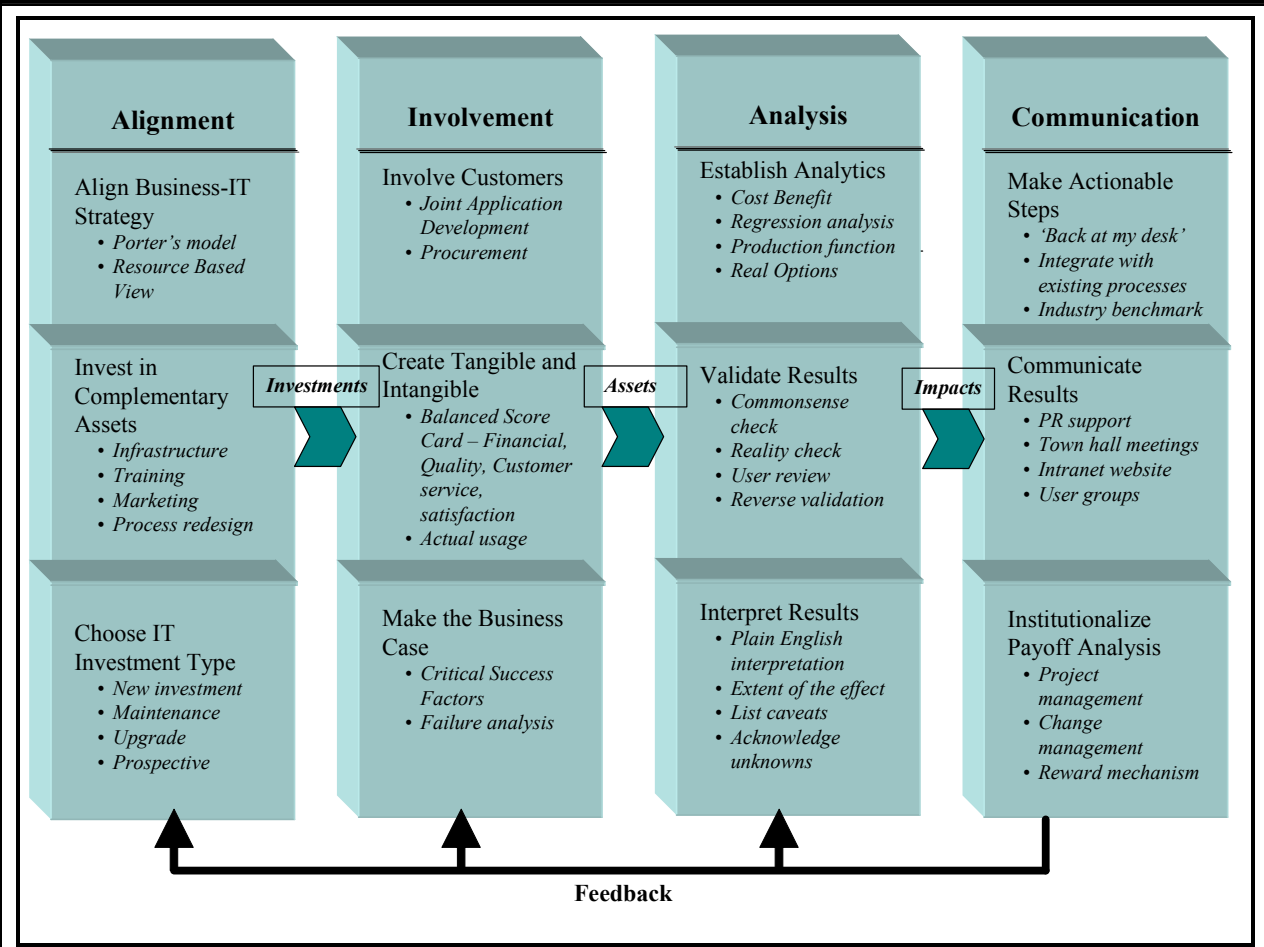
IMPLEMENTING A PROCESS TO ASSESS CIS PAYOFFS AT HOLY CROSS HEALTH SYSTEM

The details of the four phases of the AIAC framework can be demonstrated by first presenting their use in general and then their use at HCHS. The steps in each phase are shown in Figure 3. Note also that the process perspective in the framework shows that the process begins with investments to create IT assets, which are then converted into impacts, both at the process and the organizational level.

Phase I: Alignment

The alignment phase proposes that an organization can expect IT to pay off only after the IT investment is

Figure 3: An Expanded AIAC Framework With Tools And Techniques Used In Each Step

Alignment	Involvement	Analysis	Communication
Align Business-IT Strategy • *Porter's model* • *Resource Based View*	**Involve Customers** • *Joint Application Development* • *Procurement*	**Establish Analytics** • *Cost Benefit* • *Regression analysis* • *Production function* • *Real Options*	**Make Actionable Steps** • *'Back at my desk'* • *Integrate with existing processes* • *Industry benchmark*
Invest in Complementary Assets • *Infrastructure* • *Training* • *Marketing* • *Process redesign*	**Create Tangible and Intangible** • *Balanced Score Card – Financial, Quality, Customer service, satisfaction* • *Actual usage*	**Validate Results** • *Commonsense check* • *Reality check* • *User review* • *Reverse validation*	**Communicate Results** • *PR support* • *Town hall meetings* • *Intranet website* • *User groups*
Choose IT Investment Type • *New investment* • *Maintenance* • *Upgrade* • *Prospective*	**Make the Business Case** • *Critical Success Factors* • *Failure analysis*	**Interpret Results** • *Plain English interpretation* • *Extent of the effect* • *List caveats* • *Acknowledge unknowns*	**Institutionalize Payoff Analysis** • *Project management* • *Change management* • *Reward mechanism*

Investments → *Assets* → *Impacts*

Feedback

aligned with the business strategy. Alignment also implies that the organization summons all its relevant resources to fully exploit the use of the new technology.

The alignment phase responds to the common pitfall of IT investing that occurs when the investment is made without a clear and agreed-upon objective, the resources may not focus on achieving the organization's strategy. IT investments can be deployed to achieve any number of objectives, including improving customer satisfaction, increasing the customer base, or improving operational efficiency. Each could entail a different investment. Some IT investments aim to cut costs, others to deliver convenience to the customers, and still others to create new business opportunities. Although all investments aim to improve business profitability, different IT investments manifest value in different ways.

Align Business and IT Strategies

Aligning business and IT strategies is the first step in the alignment phase, as shown in Figure 3. Companies take various approaches to this step. For example, when the insurance company USAA partnered with IBM to invest in a document management system, it was aligning its business strategy of providing low-cost insurance services with the enabling potential of IT. Similarly, Sotheby.com utilized Amazon.com's infrastructure to auction artwork and earn commissions even on art sales of it competitors.

Organizations invest significant time and effort evaluating the strengths and weaknesses of their business strategy, to determine where and how they can capitalize on their strengths to generate business opportunities. Yet, that same vigor in planning and alignment is often missing in IT investment decisions. Instead, these decisions are based on costs and immediate benefits.

Each functional department should align its strategy with the organization's strategy and how its use of IT supports that strategy. For instance, finance and marketing functions should ensure that IT investments to support a marketing campaign are in line with organizational goals and will lead to expected customer responses. Similarly, the corporate development function should explore where IT can enable business opportunities that support the business strategy.

When the responsible business functions are not involved in this investment-strategy alignment step, the organization may end up with a fancy computer sys-

tem that does not do its job.[10] In spite of the frequent calls for business executives to improve this alignment, there are indications that they often believe the IT function is solely responsible for IT-business alignment.[11] When this view is held in an enterprise, IT must take primary responsibility for IT-strategy alignment.

IT-business strategy alignment should consider internal and external opportunities as well as resource requirements. Michael Porter, of the Harvard Business School, states that corporations need to incorporate IT into their business strategy formulation rather than focus on IT's operational role.[12] Technology strategy and business strategy need to be orchestrated prior to deploying IT.

Furthermore, IT managers need to understand the business, the manufacturing process, and the objectives of the organization. Henderson and Venkatraman[13] present four perspectives of strategic alignment based on the driving force—business strategy or IT strategy. Business strategy can dictate internal IT infrastructure and drive the IT strategy, just as IT can be an enabler of business strategy. The key is their alignment.

- Alignment driven by business strategy manifests in two forms. One is *strategy execution*, where the business strategy determines organizational design, IT investments, and IT infrastructure. The second is *technology transformation*, where the business strategy leads the organization to explore innovative IT, such as at USAA.

- Alignment driven by IT strategy also takes two forms. One exploits the *competitive potential* of IT, as at Sothebys.com. The second establishes a world-class *service* using IT, such as Apple providing the iTunes online channel for the sale of music.

Techniques for aligning business and IT strategies. Michael Porter's *Value Chain Analysis*[14] can be used to make a business case for IT investment and value— to identify where IT can contribute to generating

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[10] "Who's In-charge: CIO or CFO?" by Gawiser, *Management Accounting*, (76:4), October, 1994.

[11] Koller and Peacock, "Time for CFO to Step-up" *The McKinsey Quarterly*, 2002 Number 2, Risk and resilience

[12] "Competing interests," *CIO magazine*, Interview: Michel E. Porter, October 1, 1995, 63-68.

[13] Henderson and Venkatraman have created a large body of IT-Business strategy related research. For the framework cited here. see "Strategic Alignment: Leveraging Information Technology for Transforming Organizations," *IBM Systems Journal*, 38(2), 1999, 472-484.

[14] For detailed discussion and examples of applying the value chain analysis, see Porter, M.E.. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, Free Press, New York, 1980.

value. His value chain analysis framework offers a lens to view the value added by each constituency that comes together on a product or service.

He classifies organizational activities as primary or secondary. Primary activities start with the receipt of raw materials and continue through conversion to products, shipment to customers, marketing the product, and after-sales service. These activities are inbound logistics, operations, outbound logistics, marketing and sales, and service. IT can add business value at each activity by reducing costs, strengthening relationships with business partners, and creating market flexibility. The secondary activities, which cut across the primary activities, are procurement, technology development, human resources, and firm infrastructure.

Another technique for viewing IT contributions to competitiveness is called the *resource-based view*. It looks at how a firm uses its resources and capabilities better than its competitors.

Strategy alignment at HCHS. Consistent with the above-mentioned IT-business strategy alignment and Porter's value chain analysis, HCHS decided that its hospitals' cost containment motivation made 'operations' the primary focus. The business strategy was to strengthen operations using clinical and information technology as well as managerial resources.

As one executive remarked,

> *"Without accurate procedure costs, the hospitals are 'flying blind.' The managers must know the actual costs so that they can decide where to cut costs and which contracts to accept."*

HCHS decided to draw on domain experts to assess the business requirements for an activity-based Cost Information System (CIS). This investment required IT professionals, business managers, financial analysts, and clinicians to be involved. A multidimensional database tool, On-Line Analytical Processing (OLAP), would give the hospitals a way to align the IT investment with the business strategy because it would allow them to simultaneously allocate costs to produce accurate activity-based costs.

Invest In Complementary Assets

Investing in complementary assets is the second step in the alignment phase. An organization can expect meaningful payoff only when its IT investments are accompanied by changes in business processes, hu-

man resource development, and organizational redesign.

Types of complementary assets. Complementary assets need not be physical assets. Consider the IT-enabled business processes at Amazon.com and customer order fulfillment processes at Dell Computer. Both have led to extraordinary payoffs and competitive value. In both cases, the physical IT infrastructure and process know-how can be viewed as complementary assets to other IT investments.

In referring to the firm's *IT infrastructure* as a complementary investment, Weill and Vitale propose that the infrastructure is critical in executing a firm's business strategy.[15] They emphasize that it is the responsibility of IT governance to involve IT in infrastructure strategy and decisions so that the performance of the IT investment can be monitored.

In a competitive marketplace, *training* for employees who can take advantage of available IT is critical to the success of the investment. GE's Answer Center and Progressive Insurance's online quote center are examples where trained employees can be viewed as complementary assets because they exploit the technology to provide extraordinary customer service. In both organizations, the IT investments would have less value without the knowledge assets of trained employees.

Similarly, product *marketing* campaigns are complementary assets when they are essential to IT investments, such as those designed to accept and fulfill customer orders. For instance, although the information technology and employee reward systems surrounding AT&T's Universal Card were exemplary, they were exploited only after commercials aired during the Super Bowl led to a large number of customers applying by phone for the cards.[16] The IT assets provided vital information about the target customers so that future marketing campaigns (another complementary asset) could be targeted effectively.

Barua and colleagues invoke the theory of complementarity to mathematically demonstrate that changes in business processes are necessary to observe an organizational impact.[17] *Well-designed business processes*, strategically supported with complementary IT,

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[15] Weill, P., and Vitale, M. "What IT infrastructure capabilities are needed to implement e-business models?," *MIS Quarterly Executive* (1:1), Mar 2002, 17-34

[16] Shapiro, Roy D., Michael D. Watkins, Susan Rosegrant. *Measure of Delight: The Pursuit of Quality at AT&T Universal Card Services*, Harvard Business School Case 9-694-047 (1993).

[17] Barua, A., C.H.S. Lee, and A.B. Whinston, "The calculus of reengineering," *Information Systems Research* (7:4) 1996, 409-428.

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can create organizational assets that are difficult for competitors to imitate. Conversely, failure to invest in complementary changes or appropriate assets can damage current operations. For instance, when medical equipment manufacturer MacroMed did not redesign its manufacturing processes and restructure its organization, the new technology worsened its operations.[18]

Complementary assets at HCHS. HCHS decided that one complementary asset should be training—training its cost accounting managers, educating its departmental managers to exploit cost information for cost control and process redesign, and showing its marketing managers how to generate reports to use in contract negotiations.

Process redesign was a second complementary asset because it would increase the financial and patient care quality benefits to the hospitals.[19] The hospitals used a spreadsheet to identify processes to redesign. The spreadsheet ranked processes by total cost (cost x volume) as well as evaluation by managers of how well HCHS performed the activities in each process. Low-performing processes with high total costs were chosen for redesign. For instance, most of the hospitals conducted a high volume of cardiac catheterization procedures, each of which costs tens of thousands of dollars. As clinical techniques evolved, hospitals found it more difficult to track which procedures yielded the best outcomes. HCHS chose to redesign its catheterization process by partnering with the American College of Cardiologists and implementing an IT-based benchmarking system.

Other complementary assets included using information systems to generate online cost reports and execute 'what-if' decision-making scenarios.

Choose the IT Investment Type

Choosing the IT investment type is the third step in the alignment phase.

Four types of investments. Four options for investing in IT include: *new investment* (replacing existing technology with new technology if it is close to saturation), *maintenance* ('no investment,' if the business objectives so dictates), *upgrade* (enhancing an existing technology), and *prospective* (investing in tech-

nologies of the future even though they might not provide short-term returns).

Investing at HCHS. The market conditions dictated that accurate cost information was critical for the hospitals to thrive. Therefore, HCHS decided to enhance its existing decision support system by adding cost allocation and activity cost calculation capabilities. In doing so, HCHS managers developed models of market behavior under different scenarios of managed care. Accurate costs and associated activities would enable HCHS to redesign its clinical processes and automate its business processes. Combined with clinical outcome information, cost information would also establish best practices for treating patients. Thus, the decision to enhance an existing system, rather than the other options, was consistent with HCHS' business objectives of developing modeling capabilities to forecast market conditions.

Phase II: Involvement

Involvement implies involving (i) internal customers, such as finance, human resources or marketing professionals, and (ii) external end customers, such as online banking customers or software users.

Involvement hinges on IT organization and IT governance. Agarwal and Sambamurthy[20] discuss various models for organizing the IT function, all of which depend on the familiarity of internal customers' (business leadership, in this case) with IT and desire for involvement in the IT function. The authors suggest that IT functions identify the value propositions of the various models, determine the appropriate model for their enterprise, manage the transformation of the IT organization, and continuously assess and adapt the organization to the changing business needs. Given that business requirements evolve over time, customer involvement serves as an early warning system of trouble spots in the functionality or utility of the IT organization in solving business problems. From a social perspective, early customer involvement in IT investments makes the resulting system more likely to be accepted, adopted, and used by them.

Clearly, creating and measuring IT business value depends on involving internal customers in creating an agile, adaptive, and responsive IT organization. Without a close relationship with business leadership, the value of IT can be less than needed.

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[18] Brynjolfsson, E., A.A. Renshaw, and M. VanAlstyne, "The matrix of change," *Sloan Management Review* (38:2), Winter 1997, pp 37-54.
[19] Devaraj, S. and R. Kohli, "Information Technology Payoff in the Healthcare Industry: A Longitudinal Study," *Journal of Management Information Systems*, 16, 4 (2000), 41-67. This study reported that although IT investments paid off, the payoffs were most pronounced when the process redesign initiatives were taken into account.

[20] Agarwal, R., and Sambamurthy, V. "Principles and models for organizing the IT function," *MIS Quarterly Executive* (1:1), March 2002, pp 1-16.

Involve Customers

Involving customers is the first step in the involvement phase of the AIAC framework**.** End customers should be involved in an IT investment, whether it is developed in-house (make) or procured from a vendor (buy). Their involvement differs between the two.

Techniques for involving customers. End customers can be continuously involved in 'make' systems by, for example, developing the systems using a *Joint Application Design (JAD)* approach. This promotes close contact and continuous feedback between end users and developers to ensure that the system is designed to capture the users' perspective.

Bus operator Greyhound Lines lost its IT payoff because it failed to sufficiently involve internal and end customers when developing its reservation and ticketing system. To receive a bus ticket, customers had to pay by credit card and agents had to fill out information in multiple screens. The system went unused because most Greyhound passengers did not own a credit card and ticketing took significantly longer. [21]

Recently, a study commissioned by the US Census Bureau found that getting a handle on payoff metrics is a challenge and that involving customers in defining such metrics is necessary.[22]

In a 'buy' decision, user involvement in system *procurement* is shorter, but intense. While the IT function conducts technical and pricing analysis, end users need to build business scenarios to evaluate the functionality of potential systems in their business environment. Vendors tend to demonstrate the most appealing features of their system. End users must play the role of ensuring that the prospective technology can truly handle the day-to-day business functions under the stress of everyday work conditions.

HCHS's involvement of customers. HCHS was careful to involve customers early in the CIS implementation. The CIO and CFO initiated the CIS project by assigning a task force to select the project team members, including internal customers, external customers, and end users.

The internal customers included the DSS development team, VP of Finance, and VP of Corporate Development. The external customers were the hospital counterparts of the internal customers, cost accounting managers, and business analysts. The end users were department managers who would use the CIS to generate cost information and align their operating expenses with expected reimbursement.

The project team was responsible for determining the capabilities and features of the CIS that would provide strategic value to HCHS. They were also involved in procuring the supporting technology and insuring CIS's integration with other financial information systems. The team held weekly conference calls to discuss business needs, challenges encountered, and resource requirements. An intranet website held documents, meeting minutes, and project plans, and a quarterly workshop made sure the requirements encompassed the needs of all the participants. In addition, two hospitals were to serve as pilots for the first implementation of the CIS.

Create Tangible and Intangible Metrics

Creating tangible and intangible metrics is the second step in the involvement phase of the AIAC framework. Customer involvement in identifying metrics conveys what is important to them. In the past, many companies have focused on short-term ROI, not recognizing that IT investments often require a longer-term perspective. It is argued that insistence on quantifiable ROI may result in missed future opportunities that might not be apparent in the short term.[23]

Clearly, some IT investments have an operational focus and quantifiable metrics are needed to justify costs versus benefits. However, increasingly, IT is being used as a competitive advantage to ensure customer loyalty and to protect market share, both of which can take many years to acquire. Therefore, pre-investment cost-benefit analyses of such IT investments are often no more than educated guesses. With the increased scrutiny of quantifiable corporate metrics, the pendulum may have swung too far because there appears to be a backlash against tangible Return on Investment (ROI) metrics when assessing IT value.

In situations where benefits are hard to quantify, the business strategy can guide the selection and deployment of IT.

Payoff metrics. While the above discussion points to the overuse of ROI as a metric for evaluating technologies, a more recent and well-rounded perspective has appeared in the *balanced scorecard (BSC)*.[24] The

[21] Tomsho, R. "How Greyhound Lines Re-engineered Itself Right Into a Deep Hole," *Wall Street Journal*, October 20, 1994, pp. 1

[22] Mesenbourg, T. "Measuring Electronic Business," U.S. Bureau of Census, Suitland, Maryland, pp. 1-20, http://www.census. gov/eos/www/papers/ebusasa.pdf.

[23] Sawhney, M. "Damn the ROI, Full Speed Ahead," *CIO Magazine*, July 15, 2000.

[24] Robert S. Kaplan and David P. Norton, "Putting the Balanced Scorecard to Work," *Harvard Business Review*, (71:5) 1993, September-October, pp. 134-142.

BSC is used to draw managerial attention to a compendium of metrics for operational and financial performance, short term and long term.

A second metric technique is to track *actual usage*, to study patterns of use such as who uses a system, how they use it, and what modules and features they use – thereby tying use to payoff.

Payoff metrics at HCHS. At HCHS, the CIS team identified two initial CIS success metrics: (i) a reduction in the proportion of fixed costs to no more than 30% of overall costs, and (ii) an improvement in expected vs. incurred contract costs. Two downstream metrics would be higher productive hours and flexible staffing. Intangible metrics were to be staff turnover rate, contract renewal rate, and physician satisfaction.

HCHS's previous micro-costing-based CIS was marginally used because, although quite accurate, it required significant time to identify the current cost of each item. Therefore, the CIS team defined 'actual usage' of the new CIS as a tangible success metric.

In creating the metrics, internal as well as external benchmarks were developed. For internal benchmarks, the team identified best practices within the health system, while a consulting company provided external benchmarking data. As a result of the early customer involvement in defining the payoff metrics, the team's mandate was clear: the CIS must lower the percentage of fixed costs to give managers more information and greater flexibility in managing their operations.

Make the Business Case

Making the business case is the third step in the involvement phase. Most organizations investing in IT need to convince stakeholders of the need for the investment and the usefulness of the payoff metrics. The best metrics are controllable and link to business performance.

Techniques for making the business case. A successful business case presents convincing payoffs. Calculating the right types of payoffs is a key element in business case development. One technique is Rockart's *Critical Success Factors* (CSF's).[25] Developed more than two decades ago, they capture payoffs important to executives (internal IT customers). CSFs represent tangible IT payoff metrics such as quality, customer satisfaction, referrals, systems usage, and market share, and intangible metrics such as risk miti-

gation, customer loyalty, and organizational reputation.

A business case is more convincing if the IT investment can demonstrate impact upon one or more organizational CSF. Gliedman[26] suggests that an organization must be able to summarize its IT case in one sentence, such as:

> *"We are doing ____(investment)____ to make (product or service)_ better, as measured by __(metrics)_, which is worth $__(payoff)_."*

He argues that organizations that cannot fill in the blanks in this statement need to make their business case objectives clearer.

Another technique for making a business case is *failure analysis*. Learning from past failures can help organizations understand pitfalls and develop strategies and metrics to sidestep those pitfalls. For instance, organizations investing in Enterprise Resource Planning (ERP) can learn from the failure of FoxMeyer Drugs.[27]

The business case at HCHS. The CIS project team presented senior management with the business case and a development plan for the CIS investment. The case summarized the urgency of the IT investment, its benefits, and the metrics for judging its success.

Managed care, and its accompanying decreases in reimbursement for services, increased the urgency of this investment. Based on the models of market behavior (described in Phase 1), the plan outlined the timeframe for CIS completion and the risks for not containing costs. The business case projected the losses each hospital might incur from the reimbursement shortfalls from the insurance companies. The plan also showed that innovative ways to control costs, and therefore lower prices, could attract larger service contracts that could further improve hospital profitability.

In summary, the involvement phase targets the IT investment by engaging the customers, internal as well as external, and utilizes their involvement to identify appropriate metrics. An expected outcome of this phase is customer buy-in and an understanding that

[25] Rockart, J.F. "Chief executives define their own data needs," *Harvard Business Review* (52:2) 1979, pp 81-93.

[26] Gliedman, C. "Marketing the Business Value of IT." Presentation at the 5th Fall Conference on Managing Information Technologies, Oakland University, Rochester, Michigan, Oct 9-12, 2002.

[27] Scott, J. "The FoxMeyer Drugs' Bankrutcy: Was it a Failure of ERP?" in *Proceedings of The Association for Information Systems Fifth Americas Conference on Information Systems*, Milwaukee, WI, August 1999 available at http://carbon.cudenver.edu/~j1scott/publications /ScottFM99.pdf. This paper presents an in-depth analysis of the causes of ERP failure at FoxMeyer Drugs.

proper assets for IT investment have been created. Therefore, the business case and the metrics set up the need for measuring what is important to the business and how it is analyzed. Eventually, the credibility and utility of the findings will depend upon the accuracy of the analysis and the resulting actionable suggestions.

Phase III: Analysis

The analysis of an IT investment's payoffs is a stumbling block for many organizations. Untrained project leaders may use inappropriate statistical or financial analysis tools, giving them erroneous assumptions and misleading results. The types of analyses used depend on the timeframe in which the cost and benefit data will be captured, how the data will be captured, when investments will be made, and when payoffs are to be expected.

Establish the Analytics

Establishing the analytics is the first step in the analysis phase of the AIAC framework. To realize payoffs, organizations must first calculate those payoffs using methods that match the data—so that meaningful results are generated. Selecting these analytical methods requires statistical and analytical expertise. The choice of analytics depends on the context of the IT investment, the availability of data, the assumptions of the analytic procedure, and the interplay among these factors.

Types of analytics. Longitudinal and cross-sectional analyses are two approaches. *Longitudinal analyses* are useful for examining a phenomenon of interest (e.g. an IT payoff) over a period of time. *Cross-sectional analyses* present a snapshot at a given point in time.

Longitudinal analyses are most appropriate for examining the impact of IT investments on organizational performance metrics. These analyses can also detect cyclical patterns and time-lagged effects of IT. Although they can present strong, valid results, those results should not be generalized across firms or industries. A cross-sectional analysis is useful in examining a specific type of IT investment across firms or industries.

A *cost-benefit analysis* is commonly used to estimate payoffs for a one-time IT investment or an investment that can be clearly identified at specific discrete points in time—such as releases of a system. However, this technique requires objective metrics for both costs and benefits, and the findings are restricted to specific investments in a given context.

A *regression analysis* is used to test the relationship between a variable(s) and a performance metric, such as the relationship between investment in IT and productivity. It is often used to test the effect of a number of variables on a performance metric.

The *production function analysis* technique has a rich tradition in economics literature. In this technique, the primary function of a firm is viewed as transforming inputs into outputs. Input factors typically include labor, capital, material, and energy, to name a few. Outputs are the goods or services produced by the firm. If objective metrics for the principal inputs and outputs are available, a mathematical equation can represent the transformation of inputs into outputs, thereby estimating the value of an IT investment (an input) on the firm's operation.

The *real options* technique is a financial analysis technique that can be used to estimate the value of an IT investment that provides a foundation (an option) for undertaking a future business opportunity. For example, a data warehouse could be used in the future to understand clusters of customers. High-risk, high-yield businesses may find it necessary to use such proactive investment analyses approaches as production function and real options to achieve long-term IT success.

Analysis techniques used at HCHS. One of our studies at HCHS examined the impact of information system usage on hospital performance. We were able to use a longitudinal analysis to show that 'usage,' not 'investment,' had a significant impact on hospital performance.[28]

HCHS used a regression analysis to measure, in the first stage, the ability of the IT investment in a decision support system to improve hospitals' reimbursement. In the second stage, that 'reimbursement' was used as one of the variables to determine overall hospital profitability.

Validate Results

Validating results is the second step in the analysis phase of the AIAC framework. To ensure there are no surprises or questions about credibility, analysts should validate their findings by conferring with end customers. Undetected errors in findings can shake the confidence of users, especially those who were skeptical of the investment from the start.

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[28] Devaraj, S. and R. Kohli, "Performance impacts of information technology: Is actual usage the missing link?," *Management Science*, 49, 3 (2003), 273-289.

Techniques for validating results. The *common sense check* is one technique. It requires checking facts and reviewing data, looking for trivial errors, such as a misplaced decimal point.

A similar technique is a *reality check*, which compares findings with facts in the field to ensure that the analysis is not generating statistically valid but logically absurd results.

Another approach to validating results—and a valuable one—is for experienced *users to review* and interpret the data from their vantage point. Any amount of statistical or analytical work will not replace an experienced user's eye for catching errors or explaining seemingly incongruous results.

Finally, the *reverse validation* technique can be used to confirm that the findings are free of unexpected errors and that apparent errors can be explained. In reverse validation, historical data with a known outcome is used in the analysis to verify the analysis arrives at the same result. For instance, if the regression equation indicates that each dollar of investment will result in two dollars of revenue, a past investment amount can be inserted into the equation to verify the expected revenue increase.

Validating the results at HCHS. HCHS used the common sense approach to catch an error in the scale label on one report. The report listing the query duration times stated that a database query took 10 minutes. Database queries usually take a few seconds, and the HCHS database is set to timeout at 30 seconds. In this case, the scale should have indicated seconds rather than minutes. The common sense approach also uncovered a payoff analysis that reported the count of business redesign initiatives but not their weight. Without weighting, the analysis did not take into account project duration or resources consumed. Team members belonging to longer duration projects questioned the validity of the inferences drawn from this data because all the redesign projects were treated as equal.

A reality check of a CIS payoff analysis caught another error. The analysis aimed to demonstrate value from managers using information to shift fixed costs to variable costs. In the analysis, the total cost of one item dropped to less than half during one time period. The culprit: An overpayment in a previous month caused the accounting department to credit the general ledger in another month. Since the CIS draws expense data from the general ledger, the costs for the 'error' month were understated. The reality check pointed out that the previous month's expenses had been over-

stated. The solution: The CIS had to recalculate the costs for both periods and reassign monthly costs. [29]

An experienced user caught an error at HCHS. We had difficulty explaining a 2-to-3 month lag between the use of a contract modeling system and its resulting financial impact. Our experience suggested that revenue should follow immediately. An experienced user pointed out that variable 'revenue' is captured only after the bill is paid. Because accounts receivable range from 45 to 60 days, the 'revenue' impact of the contract modeling system would lag 2 or 3 months.

Interpret Results

Interpreting results is the third step in the analysis phase. Most organizations conclude their IT payoff analysis at the prior *validate results* step, and the analysts prepare reports outlining their findings. However, analysis results have limited use if they are not translated into plain and understandable language to answer such questions as, "What do the findings mean?" "Under what conditions are they valid?"

The interpretation step ensures that the payoff analyses demonstrate business significance. The findings should be summarized in a commonly used language that can be understood by non-IT professionals.

Techniques for interpreting the analysis results. The benchmark technique can be viewed as a *plain English* 90-second elevator ride answer to the COO's question, "So, what did you find out in the IT payoff analysis?"

Interpretations should acknowledge limitations of the findings and outline what can or cannot be claimed with an acceptable degree of certainty. The interpretation needs to include three elements: the *extent of the effect*, the list of *caveats*, and the *unknowns*. For results interpretation to be meaningful, people need to know what it does not mean and under what conditions the findings may not apply.

Interpreting the results at HCHS. At HCHS, the CIS-generated costs were also applied to analytical models in the financial DSS. The DSS payoff analysis cautioned that the 'actual usage' metric only tracked users of the contract-modeling component of the DSS. Therefore, the findings were less relevant for other decision makers, such as human resource managers.

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[29] For details of this costing process, see Kohli. R., J.K. Tan, F.A. Piontek, D.E. Ziege and H. Groot, "Integrating Cost Information with Health Management Support Systems: An Enhanced Methodology To Assess Health Care Quality Drivers," *Topics in Health Information Management*, 20 (1) 1999, 80-95.

Along the same lines, another interpretation of the analysis cautioned that the findings might be less applicable in markets with less competition. Therefore, other approaches to preparing contract bids might be more effective.

In interpreting the results at HCHS and examining how labor, capital, and support each contributed to hospital performance in a project, these constituents were unbundled in the IT investment. HCHS was able to make assessments about both the direction and significance (both statistical and managerial) of the impact of these IT costs on hospital revenue. Specifically, it interpreted the results of the analytical model in terms of how an increase in $1000 of IT spending would impact net patient revenue. Such interpretations can provide valuable insights into the 'levers' that managers can control to improve performance.

Phase IV: Communication

Communication is the last phase in the AIAC framework for achieving payoffs from IT investments. It responds to the common pitfall of ambiguous analysis results and lack of implications for the organization. Far too many well-executed IT payoff studies end up on bookshelves because the analysts failed to share the implications of the findings, the analysis was conducted solely to justify the IT investment, or management did not share the findings with users. Whatever the case, analysis findings are useful only when they result in actionable steps, even when they only reinforce existing practices.

Make Actionable Steps

Making actionable steps is the first step in the communication phase. The interpretation of the results should be extended so that customers learn what they need to do to convert the findings into action.

Techniques for making actionable steps. One technique is to address how people will work differently when they are *'back at their desks.'* For example, an actionable step means persuading the functional manager to actually use the system. Actual usage is the first step toward realizing the business value, but it is often the 'missing variable' in past IT payoff studies.[30]

Actionable steps generally require 'hand-holding' and helping users transition into the change resulting from the new system. In such cases, the IT function should take responsibility for educating, training, and supporting the users who can generate business value.

Another technique is to *integrate* the new system with *existing processes*. In spite of meaningful findings, some IT users may be reluctant to change their functional processes. Our experience suggests that findings and recommendations have greater acceptance when they are discussed in the context of impacts on users' current work processes and job functions. When users can relate a process change to their work, they are willing to collaborate in making the process revisions, instead of resisting them.

A third technique is to use *industry benchmarks* to compare the enterprise with an industry benchmark. This approach generally gets managers engaged in improving their processes.

Actionable steps at HCHS. At HCHS, although the value of the CIS system was understood by the customers, the CIS team believed its work was not complete. Its role had to transform from developers to trainers, public-relations emissaries, and communicators.

The team developed guidelines for each audience, such as how to create procedure-level costs (for the cost accountants), how to apply costs to each patient record (for the decision support analysts), how to use cost information for budgeting (for the departmental managers), and how to model a contract's financial performance (for the corporate development and marketing executives). The guidelines were published in hardcopy and on the intranet, in addition to being included in the training materials.

Team members also showed how the new system benefited users. For example, while developing an activity-based component of the CIS, an IT analyst spent several days with departmental managers showing them how their productivity reporting was necessary to the accurate calculation of costs in the CIS. In spite of this effort, though, these managers did not exhibit overwhelming support. However, when they were shown how accurate variable costs in CIS could change the way they allocated their employees' time, and consequently improve their departmental productivity, they bought into using the new system.

Furthermore, when industry benchmarking data was used to compare HCHS productivity and costs, the comparison engaged the managers in the CIS business value initiative. They wanted to learn about the specific differences in business practices between themselves and the benchmarked institutions.

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[30] Devaraj, S. and R. Kohli, "Performance impacts of information technology: Is actual usage the missing link?," Management Science, 49, 3, 2003, 273-289.

Communicate Results

Communicating results is the second step in the communicate phase. A survey of executive views on IT business value found that few organizations are effective at calculating and communicating the benefits of IT. While less than 10% of IT spending is seen as providing benefits to the organization, the report finds that IT spending in many organizations actually provides a return on investment between 13% and 41%.[31] These findings suggest that there is a gap between perceived and actual values of IT, and that timely organization-wide communication may be needed.

Techniques to communicate results. *Public relations support* is one approach. While one-on-one and customized communication may be required for high-profile customers, organizations need effective ways to disseminate findings to everyone. The public relations or corporate communications department can be crucial in getting the message across. They have the delivery mechanisms and the skills to make the message appealing and meaningful via newsletters, intranet, or employee forums.

The *town-hall meeting* is a second approach to announcing new IT initiatives and encouraging participation in existing ones. These meetings can effectively raise the perceived importance of the initiatives as well as answer questions. To be effective, though, these meetings need to be led by senior executives and backed by a thorough implementation plan that includes training, documentation, and support for end users. Such items can be housed on an *intranet*.

Brief presentations at regularly scheduled *user group* meetings and retreats are also effective ways to get user buy-in. Presentations and demonstrations at such meetings should be short and customized to the group. It is helpful if one or more of the members, preferably group leaders, is experienced in the business processes as well as the IT application.

Communicating results at HCHS. At HCHS, a newsletter publicized the innovative uses of cost information in various departments. In addition, presentations at user-group conferences were arranged to encourage face-to-face discussion of how managers can utilize the CIS to improve operational efficiency. For a quality council meeting, for example, a manager combined the cost information with the quality indicators to demonstrate that lower costs can, in fact, result in higher quality outcomes. In another case, a manager

suggested that by combining laboratory results with clinical systems, patient registration time could be cut in half and could enable the physician to see the patient 30 minutes sooner. In both cases, the adoption and use of CIS increased among the functional managers after they heard the presentation.

Institutionalize Payoff Measurement

Institutionalizing payoff measurement is the third step in the communication phase. Although each step described above is critical in evaluating the value of IT investments, this final step of institutionalizing the continuing payoff measurement serves a particularly important role. The benefits and knowledge derived from an IT payoff evaluation study can be leveraged by the entire organization. Learning from each others' successes provides economies of scale as well as scope, which can be applied elsewhere. For example, organizational learning from an electronic procurement system can help finance and corporate travel groups plan and implement an online travel and expense filing system.

Techniques for institutionalizing results. One technique is to standardize and document the process of payoff evaluation as part of *project management* so that others have a methodology to evaluate their IT investments. Organizations should aim to create a template for IT evaluation and make it a part of the overall IT project plan.

A second technique is *change management* seminars to help instill the change in processes, training, and reorganization. Given that organizations are socio-technical systems, managing this social part of the organization—the people involved and their attitudes towards technology—is critical.

A third is to link *reward and recognition mechanisms* to individual and team efforts to implement technologies and processes that demonstrate IT value. While change management determines whether or not IT buy-in occurs, linking efforts to reward mechanisms determines the long-term success of the change and helps sustain interest.

Institutionalizing results at HCHS. The communication phase at HCHS used several techniques. During the 18-month CIS project, one manager tracked the tasks and informally mingled with finance managers to understand how the change was progressing. His findings indicated that gathering departmental activity information took the longest time. Further examination and discussions discovered that the main reason was department managers' skepticism of the objectives of the CIS. They feared that cost information

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[31] Gliedman, C. "Measure Business Value Created by IT Spending to Fight Perceptions of Little Benefit," 2000, http://www.microsoft.com /business/articles/value/valgiga.asp.

would eventually be used to cut staff sizes and reduce budgets. In some instances, the managers inflated budgeted activities and durations to show higher productivity in their department. Given that such data could affect costs, that data required rework and consumed more time.

Clearly, HCHS needed to better manage the changes for the lab technicians, nurses, and administrative workers. Managers' anxieties and concerns also had to be addressed. HCHS responded by sharing news reports of the challenges faced by the other hospitals, how HCHS planned to respond, and the strategy that led to the CIS project. This information assured the managers that they would not be penalized for sharing departmental productivity information. On the contrary, departments received help examining and cutting costs. Managers who demonstrated exemplary approaches were publicly recognized and rewarded. Once trust between IT and the rest of the organization was established, the CIS project became highly successful, and the approach to planning, implementing, and evaluating IT investments was institutionalized. The Office of Project Management has since absorbed the methodology and is responsible for developing future plans.

RECOMMENDATIONS

Our recommendations draw from our three themes:

1. IT payoffs are the responsibility of the entire organization, not just the IT department. Although commonly referred to as the business value of IT, or IT payoff, the proper phrase is 'organizational payoff from IT.' Therefore, everyone who uses the resulting system or influences the data processed by the system should be responsible for the payoffs. Just as marketing, human resources, or accounting do not succeed without IT support, so too will IT not succeed without support and contributions from the other business functions.

2. Management of IT payoffs begins prior to the investment and continues through post-implementation. Examining IT payoffs is an extensive process that starts well before the investment is made and continues after the first set of results is obtained.

The process perspective in the framework (Figure 3) shows that each IT implementation begins with the creation of IT assets, which are converted into IT impacts that finally lead to organizational impacts. This sequence reiterates the notion that making IT investments alone is not sufficient for improved firm per-

formance. The feedback from each phase to other phases provides the opportunity for fine-tuning as investment continues. Investments following the business-IT alignment phase will translate into appropriate assets only after customers are involved in making a business case for the payoff. Next, IT impacts are ascertained when appropriate analysis is conducted and the results are translated into meaningful business actions. Finally, sustained benefits are achieved after the organization is informed of the findings and an ongoing mechanism is established to extract value from IT.

The responsibility of converting IT investments into assets and eventual impacts has fallen on the IT function. We urge the business community to recognize the role of each business function in IT implementation and create mechanisms for facilitating a dialog between IT and rest of the organization, particularly in enterprise applications such as ERP, Customer Relationship Management (CRM), and Supply Chain Management (SCM). Firms that demonstrate such cross-functional synergy will succeed in deriving significant business value from their IT investments.

For such organizations as eBay, Amazon.com, and credit card issuers, IT strategy and business strategy are virtually indistinguishable. This notion leads us to believe that there is less need for managers to demonstrate business value of IT in such organizations. Even among organizations that manufacture, sell, or deliver physical consumer products (as opposed to digital products), information about the product or the status of the product is highly valued by end customers. Hewlett-Packard's customer support Web site, Lowe's Home Improvement's online 'how-to library,' and UPS or Federal Express' online tracking system are some examples[32] of IT adding value to products by providing information about the products, how to use or maintain them, and the status of the products, respectively. In addition to value for customers, IT creates tangible value for these organizations by reducing the number of customer calls, internal tracking, and documentation printing and mailing.

3. IT payoffs are contingent upon creating and exploiting complementary assets. Realizing the maximum benefits from IT implementations requires complementary assets. To make complementary investments through change management, Peter Keen proposes developing 'hybrid managers' by recruiting the brightest and technologically savvy functional profes-

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[32] For customer support content, see http://welcome.hp.com /country/us/eng/support.html (HP); http://www.lowes.com/lkn?action= topicSelect&topic=howTo (Lowe's); http://www.ups.com/ WebTracking/track (UPS); http://www.fedex.com/us/tracking (FedEx).

sionals and training them in strategic IT thinking.[33] They not only help bring realism into the IT deployment but they also serve as ambassadors to their native functional areas. They have the functional vocabulary to facilitate change better. Other approaches may be to increase the visibility of IT by having the CIO report to the CEO and be a part of senior management. By being a peer to the COO and CFO, the CIO can form valuable partnerships and involve them in IT planning and execution.[34]

One note of caution, though. This framework is resource-intensive, requiring considerable time and effort. Just setting up the framework can be a significant investment. Thus, one-time or limited IT investments, or regulation-mandated systems, may more appropriately use a simple IT cost-benefit analysis. This framework is best suited for long-term or recurring IT investments, such as infrastructure and larger investments with strategic implications. The IT function should facilitate and encourage establishment of such a framework by drawing on existing organizational resources, such as project management, public relations, communications, and financial management.

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[33] Keen, P.G.W. Competing in Time, Ballinger Publishing Company, Cambridge, MA, 1988. p.212.
[34] "Good Business Sense" by Lofgren, C. *CIO Magazine,* October 1, 2002