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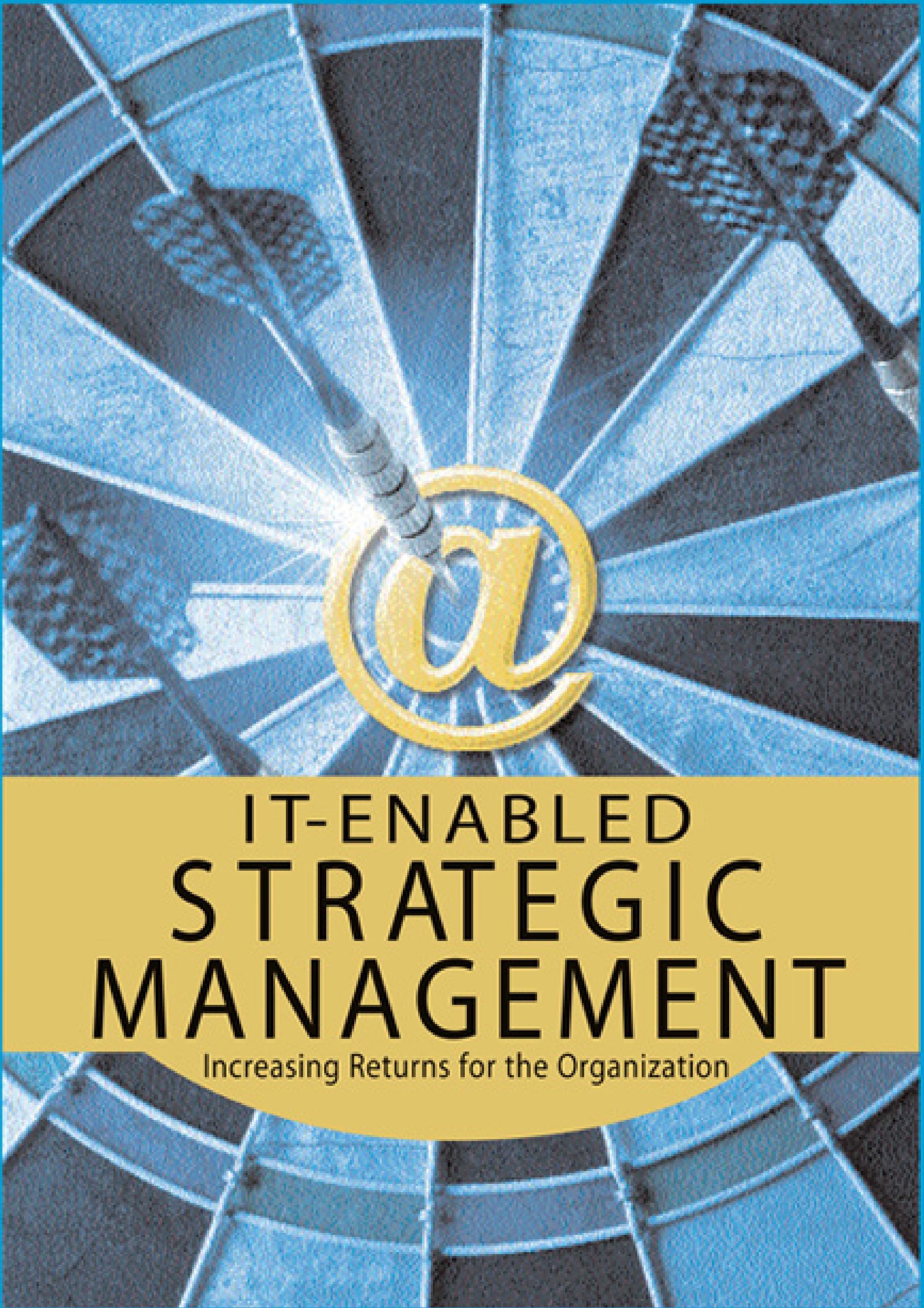

IT-ENABLED STRATEGIC MANAGEMENT

Increasing Returns for the Organization

IT-Enabled Strategic Management:
Increasing Returns for the Organization

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IT-Enabled Strategic Management: Increasing Returns for the Organization

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Preface

The unprecedented gains in information systems/technology capabilities, the rapid globalization of a range of industries and the ever-increasing need for timely, relevant strategic information in complex, hyper-competitive environments have set the stage for new challenges concerning research in strategic management and information systems alike. We believe this confluence of events represents a unique opportunity for cross-fertilization of information systems and strategic management research, broadly defined, as well as the advancement of each field. The state-of-the-art application of advances in information systems/technology and communication to a variety of strategic management issues stands to make valuable contributions both to research and practice.

The domain of strategic management broadly encompasses issues facing "general managers—those who manage multi-business firms or multi-functional business units. Major topics include: strategy formulation and implementation; strategic planning and decision processes; strategic control and reward systems; resource allocation; diversification and portfolio strategies; competitive strategy; selection and behavior of general managers; and the composition and processes of top management teams" (Academy of Management Business Policy/Strategy division domain statement). Advances in information systems research can inform scholars and practitioners regarding organizational implications of information technology; organizational transformations resulting from the astute application of information technology; the proper alignment of information systems and organizational strategy at the functional, business and corporate levels; and future strategic alternatives aided by systems advances in general.

The purpose of this book is to bring together an array of high-quality expository discussions from experts in the fields of information systems and strategic management to identify, define and explore topics relevant to both fields and, in particular, to solicit contributions from the intersection of these two fields. Our collection of chapters is intended to harness the most current research expertise in information systems/technology and strategic management in order to extend scholarship and benefit managers in increasingly turbulent and complex industry environments.

We believe our work complements other works in IT and management by filling a gap heretofore not specifically addressed. Important research has been conducted concerning the foundations of corporate success with regard to superior operations and connections with information technology and networks of suppliers and collaborators, but the emphasis here is on production/operation efficiency and supply chain management concerns. Other works have dealt with the latest thinking in information management and issues associated with the management of information systems, where the focus is primarily on MBA, master's-level students and senior undergraduate students taking courses in information management. Other research has offered expert guidance, real-world advice and practical methodology managers can use to ensure that their IT dollars are wisely invested, including methods to help managers make the right IT decisions and optimize asset management and minimize ongoing total cost of ownership. Finally, other contributions have addressed the evolution of infrastructure designed to handle a variety of goals, projects and deadlines. Proper infrastructure planning includes infrastructure planners directly involved in strategic application decisions upfront.

The aforementioned are representative of current works dealing with information systems/technology and management, but they either tend to be focused on operational issues (e.g., supply chain management) or the internal sales effort related to IT proposals and implementation in organizations. To our knowledge, ours is among the first books to explore the most current research at the intersection of strategy and information systems/technology applied to strategic management and aimed at academics as well as practicing managers. It incorporates cutting-edge research aimed at applying information systems/technology advancements to strategic decision-making in general and includes a range of strategic management topics. In short, this point in history represents a unique opportunity to capture myriad cross-benefits emanating from the intersection of these fields.

This book should be useful as a core text in specialized courses, a supplement to core courses and a resource guide for both strategic management and information systems/technology researchers. Although the topics are grounded on sound theoretical footing, the treatment of the topics is also accessible to practicing managers, and we expect organizations to profit from the practical application of these findings. Parenthetically, at our own institution, we have recently combined the Computer Information Systems and Analysis department with the Management department, resulting in the newly formed Department of Management and Information Systems. We anticipate that MBA programs may continue to evolve into "high-tech" or "management of technology" MBAs, in keeping with current trends. We believe our book represents contributions at the forefront of research that realizes synergies among technology and organizational issues, thereby benefiting research, practice and forward-thinking education at the graduate level.

The book is organized into four sections. The first section, consisting of four chapters, is titled *Perspectives on IT-Enabled Strategic Management*. Primary aims in this section are broad coverage of strategic management and information technology/systems topics, implications for the organization as a whole and future research agendas.

In Chapter I, Zaiyong Tang and Bruce Walters trace the parallel development and growing convergence of strategic management and information technology research. The case is put forth that, although each field has clearly distinct aims, they also increasingly complement each other on a variety of fronts, including operational processes, strategic decision-making and strategy implementation issues.

Chapter II, by Paul L. Drnevich, Jungpil Hahn and Mark Shanley, argues that MIS research can benefit by incorporating a comprehensive understanding of core theoretical perspectives in strategic management. A key aim is to offer a framework by which to evaluate the impact on firm performance of future MIS research agendas.

Chapter III, by Brian H. Cameron, offers a view of IT strategic alignment from the perspective of financial portfolio management. Projects are seen as being managed together as a portfolio that meets stated corporate goals and objectives.

In Chapter IV, Miguel Pérez-Valls, José Ortega-Egea and José Antonio Plaza Úbeda argue that IT innovations can be regarded as both cause and consequence of the emergence of more flexible and virtual organizational forms. As industry environments become more dynamic, flexible organizational structures can be seen as a way to adapt to changes as well as proactively influence industry conditions.

The second section, consisting of four chapters, is titled *Processes and Capabilities*. Contributions highlight various applications and processes facilitated by the judicious deployment of IT-enabled systems in organizations. The authors offer fresh treatments of organizational capabilities, knowledge management, the learning organization and IT integration.

Chapter V, by Paul L. Drnevich, examines new organizational capabilities arising from the rapid evolution of IT advances, offering a view of firm activities as knowledge inflow, intraflow and outflow processes. This new environment presents challenges to existing views of strategic management theory, but also presents unique opportunities for the enhancement of competitive advantages.

In Chapter VI, Dev K. Dutta discusses the Software Engineering Institute's Capability Maturity Model of software improvement in terms of a firm's ability to transform itself into a learning organization. A method of assessment is presented by which an organization can consider the degree to which it is achieving the appropriate learning goals.

In Chapter VII, Les Singletary and Minh Q. Huynh describe the evolution of IT integration strategies and examine ERP as a popular IT business strategy. The major theme is IT integration, and the authors examine the question, "Is IT integration desirable?"

Chapter VIII, by Sreedhar Madhavaram and Radha Appan, argues that marketing strategy is responsible for ensuring that all aspects of a firm's marketing activities are focused on delivering superior value to customers. The authors explore various information technology-enabled capabilities that influence the firm's marketing strategy, and they call for strategically oriented research for exploring, conceptualizing, developing and measuring information technology-enabled capabilities that influence marketing strategy.

The third section, consisting of three chapters, is titled *Technology and Tools*. These chapters concern technological and methodological considerations in decision-making. Intelligent mobile agent-based systems, business-to-business (B2B) applications and technological enhancement of environmental scanning address decision quality and efficiency of information management.

In Chapter IX, Tong-Seng Quah and Chye-Huang Leow describe a specific application of an intelligent mobile agent-based system that links hotels and restaurants to provide a convenient way of searching for choice restaurants. Benefits include less information overload for users and increased revenue for businesses.

Chapter X, by Yuan-Yuan Jiao, Jun Du and Jianxin (Roger) Jiao, proposes a directory service-enabled infrastructure model for B2B applications, called the IAAIBB model, for centralizing the identification, authentication and authorization infrastructures. The authors illustrate how this model enables a sound trust relationship for B2B applications, and provide an evaluation of the model's advantages.

In Chapter XI, Sören W. Scholz and Ralf Wagner discuss how environmental scanning impacts managerial decisions by linking the business environment with internal organizational capabilities. Based on the Information Foraging Theory, the authors propose an innovative approach to assessing the information gain offered by digitally available sources.

Section IV, *Inter-Organizational and Global Implications*, deals with inter-organizational relationships enabled by IT. Topics include IT outsourcing decisions, organizational effectiveness of multiple business partners and IT-enhanced economic growth and development.

Chapter XII, by Luke Ho and Anthony S. Atkins, provides insight into IT outsourcing, arguing that outsourcing decisions tend to focus on short-term benefits and often lack strategic direction. A framework is presented wherein such decisions may be evaluated in light of environmental turbulence.

In Chapter XIII, Jari Salo presents a longitudinal case study focusing on changes brought about by technology integration in the context of the steel industry. A key conclusion is that information technology integration within a business relationship is a complex process that depends on characteristics both of the adopted technology and the relationship.

Finally, in Chapter XIV, Elias G. Carayannis and Christopher Ziemnowicz present a global perspective of how information and communication technology (ICT) can enable economic growth and convergence. The authors use examples from the European Union's Central and Southeastern European members, and argue that ICT provides opportunities for governments to transform themselves as well as the way they provide products and services to individuals.

In summary, this book contains outstanding contributions from leading thinkers exploring the crossroads of information technology/systems and strategic management. There is substantial variety in terms of technical applications, organization-wide ramifications and implications for strategic decision-making. Examples include specific market enhancements, information management for decision-making, inter-organizational efficiencies, the importance of maintaining crucial relationships and broader societal and global ramifications. We believe this fills an important void heretofore not adequately addressed. Although we recognize recent work focused on IT- and strategy-related topics, this book should play a part in encouraging continued deliberate cross-fertilization in these critical research areas at a very strategic point in history. As previously mentioned, although the parallel development of these fields continues, globalization and technological advances have set the stage for convergence of these fields in a number of arenas. We hope you find the subsequent chapters stimulating, as they incorporate cutting-edge research aimed at applying information technology and strategic management concepts to a wide range of topics. We trust that your future research and professional activities will be enhanced by these efforts.

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Special thanks also go to L. D. Briggs for his substantial contribution to our editorial efforts. We also thank Shalini Wunnava, Michael C. Posey and Avinaya K.C., graduate students at Louisiana Tech University, for their clerical assistance and encouragement, particularly during the final stages when organizational challenges were at a peak.

In closing, we wish to thank all of the authors for their insights and excellent contributions to this book. We also want to thank all of the people who assisted in the reviewing process. Finally, we want to thank our families for their love and support throughout this project.

Bruce Walters

Zaiyong Tang

Editors

Section I:

Perspectives on IT-Enabled Strategic Management

Chapter I

The Interplay of Strategic Management and Information Technology

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Abstract

The authors trace historical developments in the fields of information technology (IT) and strategic management. IT's evolution from the mainframe era to the Internet era has been accompanied by a shift in the strategic emphasis of IT. In the early days, IT's contribution to the organization was largely information provision, monitoring and control. Current research at the intersection of IT and strategic management increasingly highlights the impact of IT in terms of informing strategic decisions and enabling information flow vis-à-vis all manner of organizational processes. We believe these fields are ripe for research focusing on their complementary impact on organizational performance.

Introduction

We live in an age in which the value of information and knowledge has far surpassed that of physical goods. Information resources have become a key differentiator of successful businesses. Information technology (IT) and information systems (IS) are now integrated in almost every aspect of business, from planning to analysis and design, operations management and strategic decision making. Even for those businesses not in information industries, information plays a vital role in supporting their business functions, from routine operations to strategizing. John Naisbitt (1982) theorized that information would be the driving force for organizations. Companies that manage information well are more likely to maintain a competitive advantage against their peers. Because information has become a major force in driving business activities, Evans and Wurster (2000) proclaimed that every business is in the information business.

IT and IS have experienced dramatic changes in the last few decades. Their major role in business has shifted from tools to support "back-office" operations to an integrated part of business strategies and the maintenance of core competencies. Strategic management, as the process of business strategy formulation and strategy implementation, is concerned with establishing goals and directions, and developing and carrying out plans to achieve those goals. As organizations evolve, so do their strategies and strategic management practices. In recent years, IT has become increasingly important in strategic management. IT and IT-enabled systems are now indispensable in supporting business strategies. In this chapter, we examine the evolution of information technology and strategic management, and their interplay in the last 50 years. We start with a review of major theories and development in both strategic management and IT, and then explore how IT has become an enabler for strategic management. We also discuss research issues in IT-enabled strategic management, and suggest future directions in this cross-disciplinary research field.

Strategic Management

Strategic management is concerned with managerial decisions and actions that determine the long-term prosperity of the organization. An organization must have a clear strategy and its strategy must be carefully developed and implemented to match its resources and environment in the pursuit of its organizational goals. Two meanings behind the often-used term "strategy," as Lowell Steele (1989) pointed out, are the ideational content of strategy and the process of formulating strategy. The former refers to the array of options that one uses to compete and survive, and the latter refers to the planning that leads to the construction of the strategic plan. Thus, IT-enabled strategic management must address the role IT plays in strategy content options and priorities, strategy formulation processes and strategy implementation processes. Strategic management focuses on identifying the direction of an organization, and designing and instituting major changes needed to gear the organization towards moving in the established direction.

Early research in strategic management started in the 1950s, with leading researchers such as Peter Drucker, Alfred Chandler and Philip Selznick. Drucker (1954) pioneered the theory of management by objectives (MBO). He is also one of the first to recognize the dramatic changes IT brought to management. He predicted in the 1960s the rise of knowledge workers in the information age (Drucker, 1968). Alfred Chandler (1962) recognized the importance of a corporate-level strategy that gives a business its structure and direction; as he put it, "structure follows strategy." Philip Selznick (1957) established the ground work of matching a company's internal attributes with external factors.

In the 1970s, theories of strategic management primarily focused on growth, market share and portfolio analysis. A long-term study aimed at understanding the Profit Impact of Marketing Strategies (PIMS) was carried out from the 1960s to the 1970s. The study concluded that a company's rate of profit is positively correlated with its market share. This is a result of economies of scale (Buzzell & Gale, 1987). As companies pursued larger market share, a number of growth strategies—such as horizontal integration, vertical integration, diversification, franchises, mergers and acquisitions, and joint ventures—were developed. As will be discussed later, those strategies are even more widely used today, with the facilitation of information and networking technologies.

Another shifting of strategic focus occurring in the 1970s was the move from sales orientation towards customer orientation. Researchers such as Theodore Levitt (1983) argued that businesses should start with the customer proposition. The right approach is to find out how to create value for customers and then make the products and services that meet the needs of the customers, rather than trying to sell to customers once the products are created.

In the 1980s, strategic management theories were largely geared towards gaining competitive advantages. Michael Porter (1980, 1987) proposed a number of very influential strategic analysis models, such as the five-forces model of competition, the value chain and generic competitive strategies. Porter suggested that businesses need to choose either a strategy of cost leadership (with lowest cost), product differentiation or market focus. Research has demonstrated that both market share leaders and niche market players may obtain high financial returns while most companies without a coherent strategy did not (e.g., Levinson, 1984). Adopting one of Porter's generic strategies helps a company to avoid the so-called "stuck-in-the-middle" problem. Many of Porter's ideas have been implemented in modern corporate strategic management frameworks. Strategic IS applications, such as supply chain management, are based on efficient value chain management and forming strategic alliances to maintain competitive advantages.

Lester (1989) suggested that companies sustain their strategic positions in the market by following seven best practices: continuously improving products and services, breaking down barriers between functional areas, flattening organizational hierarchies, strengthening relationships with customers and suppliers, effectively using technology, having a global orientation and enhancing human resource quality. Various information technologies have been used to support those best practices.

Hamel and Prahalad (1990) popularized the idea of core competencies. They argued that companies should devote their resources to a few things that they can do better than the competition, and relegate non-core business operations to business partners. This laid the foundation for outsourcing, which has gained in popularity since the late 1990s. The wide spread of information and network technologies has reduced the time and geographic barriers of outsourcing business functions to other companies.

Reengineering, also known as business process redesign, calls for fundamental changes in the way business is carried out. Traditional companies are organized around functional business areas, which often leads to limited communication and cooperation, as well as redundancy due to functional overlap. Hammer and Champy's book, *Reengineering the Corporation,* makes a convincing case for restructuring business resources around whole business processes rather than functional tasks (Hammer & Champy, 1993). IT and IS have become both an impetus and a facilitator for reengineering projects.

In the 1990s, researchers increasingly recognized the importance of customer relationship management (e.g., Gronroos, 1994; Sewell & Brown, 1990). Computer and network technologies have played a key role in making customer relationship management efficient and effective. Along the line of improving value to the customers, mass customization provides competitive advantages (Pine & Gilmore, 1997). Reaching and custom-serving individual customers are only feasible with the proliferation of information and communication technologies.

Peter Senge (1990), in his book, *The Fifth Discipline,* popularized the concept of the learning organization. The rationale in creating a learning organization is that the business environment has become more dynamic and complex. Companies must have the ability to learn continuously and adapt to the changing environment. People in a learning organization need to continuously expand their capacity to become more productive or to maintain their level of competency.

The Greek philosopher Heraclitus said nothing is constant but change. Indeed, Toffler (1970) has recognized that not only is Heraclitus still right, but the rate of change is accelerating. Hamel (2000) believes that all strategies decay over time; thus, organizations need to reexamine their strategies and strategic management practices. Moncrieff (1999) argues that strategic management is a dynamic process. Strategy is partially deliberate and partially unplanned. Recently, many researchers have recognized that organizations are complex adaptive systems in which multiple agents set their own goals, share information, collaborate and interact with one another (Axelrod & Cohen, 1999; Dudik, 2000; Landsbergen, 2005). Two foreseeable trends are: 1) more IT-enabled interactions among human agents in the complex adaptive systems, and 2) agent activities moving from purely human interaction to interactions involving artificial intelligent agents.

The Evolution of IT

IT can be defined as technology applied to the creation, management and use of information. Any technology that deals with information gathering, processing, storing and dissemination is considered IT. Earlier examples of IT include pigeon carriers and sending messages by fire and smoke. By definition, IT does not have to be computer-based. However, practically speaking, today's IT is largely built on computer hardware and software applications. Thus, in the following, while we review IT development in the past, we focus on computing-related technologies.

An early and relatively sophisticated computing device was the abacus, invented around 500 B.C. in Egypt. Blaise Pascal invented the first mechanical calculating machine for adding and subtracting in 1642. A milestone in computing machine development was Charles Babbage's difference machine that could perform trigonometric and logarithmic operations. The first electronic computer, ENIAC (electronic numerical integrator and calculator), was developed in 1946. Commercially available computers began in the early 1950s, with IBM as the leading vendor.

One of the milestones in the computer industry was the arrival of the IBM System/360 in 1964. The System/360 was a family of computers running the same operating systems and using the same peripherals. Thus, companies could start with a less capable model and expand the capacity with more powerful models without the need to replace system software and peripheral components. Easy adoption through inter-changeability of hardware and software prompted significant growth of computer system usage in business in the 1960s and 1970s (with later models, such as the System/370). IBM first started unbundling software from hardware by selling software separate from its computer in 1969. That set the stage for the launch of an independent software industry. The fast growth of packaged software applications, in turn, prompted the growth of computer hardware.

The next major event in the computer industry was the birth of personal computers (PCs) in the mid-1970s. Intel introduced the first semiconductor microchip (the Intel 4004) in 1971. However, PCs were not widespread until the early 1980s, when IBM launched its standardized PC (known as the IBM PC). The IBM PC became "Machine of the Year," taking the place of traditional "Man of the Year" on the cover of *Time Magazine* in 1983. Other computer vendors jumped on the IBM PC bandwagon by producing IBM-compatible PCs. During the decade of the 1980s, the number of PCs grew more than 100 fold to more than 100 million (Gantz, 2004).

The continued growth of the PC industry is driven by the well-known Moore's Law, which stipulates that the number of transistors per silicon chip doubles roughly every 18 months; hence, the corresponding performance of the central processing unit—the brain of microcomputers. Gordon Moore, co-founder of Intel Corp., made that stipulation in 1965. Amazingly, Moore's Law has described the state of affairs for the last four decades. The power of exponential growth resulted in dramatic cost and performance improvement of computer hardware. Once scarce and expensive, computer systems are now abundant and inexpensive because of the availability of desktop computer, laptop computers, and even handheld computing devices. Low-cost computing changed organizational computing architecture from centralized computing to distributed computing systems in the 1980s.

In the history of IT, the 1990s is perhaps best known as the decade of Internet booming. The Internet started as the U.S. Department of Defense's ARPAnet, with the aim of creating a distributed computer network that can withstand a nuclear attack. In the 1970s and 1980s, the Internet was used mainly by academics and scientists, and was not accessible largely to the general public because its use, although open, required substantial learning of arcane application protocols. Two major events led to the explosive growth of the Internet. The first was the development of the World Wide Web (WWW or the Web) by Tim Berners-Lee, a researcher at the CERN Institute in Switzerland in 1990, and the second is the arrival of (largely free) graphic Web browsers. The Web made it possible to link information resources all over the world on the Internet. Users could retrieve information without knowing the whereabouts of the information by simply following the hyperlinks (or links). However, initial access to the WWW was text-based; hence, its richness in content and usability were limited. The WWW took off after 1993 when the first graphic Web browser, Mosaic, was released by the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana Champaign. The ensuing Internet growth was unprecedented in the history of technology development. Internet users grew from a few thousand to more than 300 million during the 1990s. As of June 2005, there were more than 938 million Internet users worldwide (www.internetworldstats.com/stats.htm).

The Internet provides a low-cost way of connecting virtually everyone in modern society to an open and shared common network. The wide accessibility of the Internet has created numerous opportunities for businesses and brought fundamental changes to the way businesses operate. The value of a network increases with the square of the number of users connected to the network. This is known as Metcalfe's law, attributed to Robert Metcalfe, one of the inventors of the widely used Ethernet standard and founder of 3Com Corporation (Applegate, Austin, & McFarlan, 2003). The Internet has changed the landscape of competition by lowering the barriers for small- and medium-size companies to reach markets that were traditionally accessible only to large corporations.

Since the late 1990s, mobile computing based on wireless network technologies has gained much momentum. Intelligent appliances, such as cellular phones, personal digital assistants and other handheld computing devices, are becoming a significant part of the IS infrastructure. IDC predicts that the number of mobile devices connected to the Internet will surpass that of Internet-connected computers by the end of 2006. The total number of networked devices may approach 6 billion by 2012 (Gantz, 2004). Ubiquitous computing that allows "anytime, anyplace" access to information resources will bring dramatic changes to the business environment.

The Internet has already created fundamental changes in the business world. The WWW brought the first revolution in our networked society. Many believe that the next major development of the Web may be network intelligence through Web services. The non-profit Internet governing organization W3C defines Web services as the programmatic interfaces for application to application communication on the Web. Web services create a promising infrastructure to support loosely coupled, distributed and heterogeneous applications on the Internet (Nagarajan, Lam, & Su, 2004). Applications based on Web services can be described, published, located and invoked over the Internet to create new products and services based on open Internet protocols such as HTTP, XML and Simple Object Access Protocol (SOAP). The significance of Web services is that system-to-system communications can be automated; hence, building business alliances and virtual organizations becomes much easier than with current Internet technology.

IT as an Enabler for Strategic Management

Although strategic management and IS developed in parallel over the last 50 years, the two fields have also had substantial impact on each other. The interaction and co-evolution of the two fields have experienced significant increase in recent years. In this section, we will examine such interaction and co-evolution through the motivations and development of computer-based IS used in businesses.

The short history of computer IT development can be divided into three eras: the mainframe era from the 1950s to the 1970s, the microcomputer era from the 1980s to the early 1990s, and the Internet era from the 1990s to the present. The mainframe era is characterized by centralized computing, where all computing needs were serviced by powerful computers at the computer center. The proliferation of microcomputers led to decentralized computing. Computing resources become readily accessible to more users. This is a period that witnessed improved user performance and decision-making quality. When computer networks became pervasive in the Internet era, decentralized computing evolved to distributed computing, where computing resources are located in multiple sites, as in decentralized systems, but all of the computing resources are connected through computer networks. People in the Internet era are far more empowered than in previous eras, because they have access to not only technology tools as before, but also to shared knowledge from others. Table 1 summarizes the IS and their motivations during those three IT evolution eras. Although IS are separately listed in the three eras, we must point out that the lists are not mutually exclusive. In particular, in the Internet era,

Table 1. IT evolution and strategic management relevance

	Mainframe Era 1950s to 1970s	Microcomputer Era 1980s to early 1990s	Internet Era 1990s to present
Dominant technology	Mainframes, stand-alone applications, centralized databases	Microcomputers, workstations, stand-alone and client-server applications	Networked microcomputers, client-server applications, Internet technology, Web browser, hypertext, and hypermedia
Information systems	Transaction processing systems (TPS), management information systems (MIS), Limited decision support system (DSS)	Comprehensive decision support system (DSS), executive support systems (ESS), enterprise resource planning (ERP) business intelligence (BI), human resource management (HRM), expert systems (ES)	Supply chain management (SCM), customer relationship management (CRM), knowledge management (KM), strategic information systems (SIS), multi-agent systems (MAS), mobile information systems
IS motivation	Efficiency	Effectiveness	Business value
Strategic management relevance	Provide information for monitoring and control of operations	Provide information and decision support for problem solving	Support strategic initiatives to transform organizations and markets

Adopted from Applegate, Austin, and McFarlan (2003) businesses are still heavily dependent on systems conceptualized and developed in earlier eras, such as TPS, MIS and DSS.

Clearly, the role of business IS has evolved and expanded over the last 5 decades. Early systems in the 1950s and 1960s were used primarily for dealing with business transactions with associated data collection, processing and storage. Management information systems (MIS) were developed in the 1960s to provide information for managerial support. Typical MIS are report based, with little or no decision-making support capabilities. Decision support systems (DSS) first appeared in the 1970s. They offer various analytical tools, models and flexible user interface for decision support at solving difficult problems, such as planning, forecasting and scheduling. Executive support systems (ESS) are specialized DSS designed to support top-level management in strategic decision making (O'Brien, 2005).

The 1990s saw an increased emphasis on Strategic Information Systems as a result of the changing competitive environment. Competitive advantage became a hot strategic management topic. IT and IS were developed to support business strategic initiatives. The commercialization of the Internet in the mid 1990s created an explosive growth of the Internet and Internet-based business applications. Using the Internet standards, corporations are converting their old incompatible internal networks to Intranets. Also based on Internet standards, Extranets are built to link companies with their customers, suppliers and other business partners (Chen, 2005).

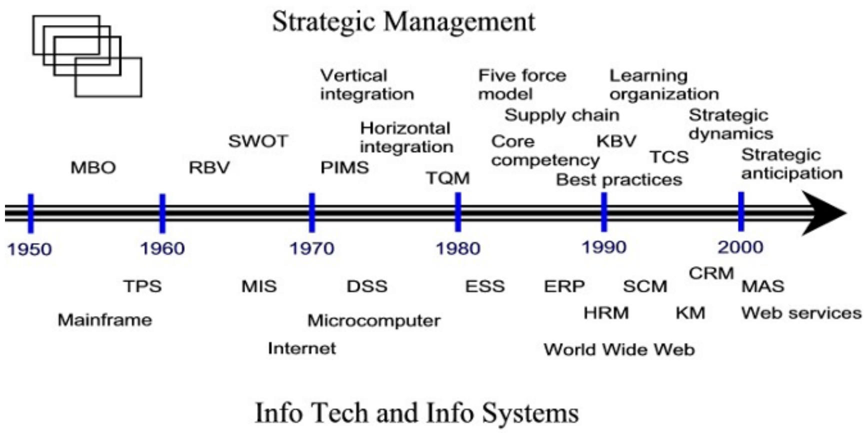
What kind of information systems would be considered strategic information systems? Although strategic support systems are almost exclusively used for top executives dealing with strategic problems, a strategic information system can be any type of IS that plays a key role in supporting business strategies. McFarlan's strategic grid defines four categories of IT impact: Support, Factory, Turnaround and Strategic (Applegate, Austin & McFarlan, 2003). When the IT has significant impact on business core strategy, core operations or both, the corresponding IS are considered strategic information systems. Thus, various information systems may be dealt with in strategic management.

Many researchers have written on the strategic importance of information and knowledge in the networked economy. Nasbitt (1982) observed that the world was transforming from an industrial to an information society, and IT would dominate the economic growth of developed nations. Quinn (1992) argued how knowledge- and service-based systems are revolutionizing the economy. Shapiro and Varian (1999) discussed information-based products and services, and how to use information to maximize economic gain.

IT and IS have made it possible to access vast amounts of information easily and quickly. Systems such as enterprise resource planning (ERP) give managers the ability to monitor the operation of the entire organization in real time. Executive information portals have allowed senior managers to take a much more comprehensive view of strategic management than ever before. Tools such as the balanced scorecard (Kaplan & Norton, 1992) give a holistic view of the business performance by integrating factors in multiple business functions.

In the last few years, business process management (BPM) software has been designed with the intent of closing gaps in existing ERP deployments. As companies are increasingly faced with problems associated with incompatible functional systems from different vendors, enterprise application integration (EAI) has become an important research.

Figure 1. Chronology of strategic management and IT development

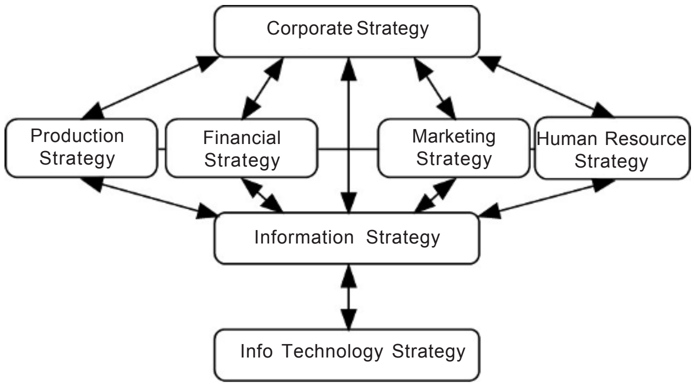


BPM systems have been deployed to lower the cost and complexity of application and data integration. Another recent development is Web services enabled by standards-based protocols (such as XML, SOAP, UDDI and WSDL). The wide acceptance of Internet protocols also led to the emergence of service-oriented architectures (SOA). SOA focus on building robust and flexible systems that provide services as they are requested in a dynamic business process environment. Instead of being programmed in advance, services are generated, brokered and delivered on the fly. Figure 1 presents a timeline that lists major developments in strategic management and IT/IS. Although the two fields have progressed in their separate paths, there are many instances where their paths crossed. As shown in Table 1 and the discussion following it, the motivation of IS has shifted from efficiency to effectiveness, and in the Internet era, to value creation. On one hand, IT is playing a more active and important role in strategic management. On the other hand, strategic management concerns have influenced the development of IS. In many cases, the theories and principles of strategic management led the way of IS development. IT and IS, in turn, have made it more feasible for those theories and principles to be practiced in businesses.

IT Alignment with Business Strategies

IT in business has evolved and become increasingly integrated with business organizations. Strategic management now encompasses corporate strategy, functional business strategy, information strategy, and IT strategy, as shown in Figure 2. For most businesses, their strategies form a multi-level hierarchy. At the very top is corporate strategy, which sets the direction for corporate-level decision making. Below corporate strategy, there are functional strategies, business unit strategies and operational

Figure 2. Alignment of information technology with strategies



Adopted from Boddy, Boonstra, and Kennedy (2005).

strategies. Building a comprehensive strategic IT plan that aligns with the business strategy is essential to ensuring the success of the organization.

Numerous researchers have indicated that IT alignment with business strategy is vital to achieve expected results. Sabherwal and Chan (2001) studied the benefit of alignment between business and IS strategies, and concluded that the alignment can improve business performance. They also developed a framework that can be used to analyze the level of alignment between business and IS strategy. Symons (2005) claimed that IT alignment has been one of the top three issues confronting IT and business executives for more than 20 years. Symons reported that a recent poll of CIOs and business executives revealed that the alignment of IT and business goals is their no. 1 or 2 priority. Measuring the degree of IT alignment has been difficult for many businesses. Borrowing the idea from the Capacity Maturity Model (CMM) of the Software Engineering Institute, Symons proposed a strategy alignment maturity model with five distinct levels:

- At the base level, called Nonexistent, there is IT alignment with business strategy. IT plays only a supportive role of operations.
- At the Ad hoc level, the need for IT alignment is recognized, but there is a lack of systematic approach. IT supports business goals on a case-by-case basis. There is no attempt to measure the success of IT alignment.
- At the Repeatable level, IT alignment is considered at the enterprise level. However, it is only implemented in some business units. Limited measures of IT alignment exist.
- At the Defined process level, IT alignment is systematically implemented throughout the enterprise, with appropriate policies and procedures to monitor and measure the benefits of the IT alignment.

- At the Optimized level, IT strategy is seamlessly aligned with business strategy at all managerial levels and in all business units. IT alignment processes have been extended to external best practices with other organizations. Measures of IT alignment and feedback mechanisms exist to ensure that IT alignment stays at this level.

Obviously, IT alignment is one of the key issues in strategic management. However, IT alignment is more than simply formulating IT strategy to fit the business strategy. Business strategy is future oriented and subject to external forces and environmental uncertainty. IT alignment should build adaptability into IT strategy. Furthermore, for some technology companies, IT may be the driver of corporate strategy (Clarke, 2001).

Strategic management is concerned with the long-term survival and prosperity of organizations. As the environment changes, organizations must also adapt to maintain their viability. Organizations evolve, and so do strategies. Thus, strategic management is also a learning process. There are four basic learning behaviors in strategy formulation; namely, natural selection, imitation, reinforcement and best reply (Young, 1998). In each of the four learning processes, IT and IS are becoming indispensable.

Natural selection stipulates that organizations that use high-payoff strategies have competitive advantages over those using low-payoff strategies. As a result, high-payoff strategies have a better chance to be continued by surviving organizations. Determining the payoff of strategies, thus, is very important in this kind of strategic learning behavior.

Imitation describes how organizations mimic the practices of successful peers in their industry. This is the cause of herding behavior in which the outcome is not clear, but organizations jump on the bandwagon, simply following what many of their peers are doing. A classic example is the dot.com boom during the late 1990s.

Reinforcement is concerned with how organizations monitor their own behaviors and favor the strategies that resulted in high payoffs in the past. In contrast to *natural selection*, *reinforcement* learning is based on one's own experience rather than others' experience.

Best reply is the behavior wherein organizations formulate their strategies based on what they expect their competitors will do. Many of the popular competitive strategies, such as low-cost leadership and differentiation, fall into this category.

Research Issues in IT-Enabled Strategic Management

There is no doubt that the application of IT and strategic information systems has aided businesses in gaining competitive advantages. However, the extent to which IT/IS helps businesses to succeed varies, as many other factors also contribute to the long-term performance. Kettinger and colleagues (1994) studied a large number of cases of strategic information systems and found that 40% of the companies had above-average performance in the short to intermediate term, while only 20% of the companies sustained long-term (10 years or more) competitive advantages. Thus, for many of those companies, their strategic investment in IT and IS did not achieve their long-term goals.

In 2003, *Harvard Business Review* published a controversial article titled “IT Doesn’t Matter.” The author of the article, Nicolas Carr, contends that since IT cost has dropped precipitously in recent years, and now IT is widely accessible to businesses large and small, IT no longer provides a competitive advantage to businesses. Thus, companies should stop investing heavily in advanced IT products and services. Rather, they should spend the resources on reducing operational risks associate with IT (Carr, 2003). Although many scholars and industrial leaders, such as Warren McFalan, Richard Nolan, Paul Strassmann, John Brown, John Hagel and Vladimir Zwass (see Stewart, 2003), have debated Carr’s view, and have shown evidence of the strategic importance of IT, it is generally agreed that IT alone is not enough to sustain strategic advantages. Although IT plays an important role, it is only one facet of the comprehensive framework of strategic management. As Clemons and Row (1991) argued, IT’s value is not so much in its intrinsic properties, but in how it can be effectively deployed to support business strategies. Although numerous previous researchers have studied IT’s importance and its strategic value (e.g., Clarke, 2001; Porter & Miller, 1985), there is a lack of strategic research on integrating IT into strategic management.

In recent years, IT-enabled business changes have become more frequent and more crucial. Prahalad and Krishnan (2002) have surveyed business executives in large companies and found that almost invariably, the executives indicated that the quality of their IT infrastructure fell short of their need and desire for strategic change. In such a case, (existing) IT became an impediment to innovations and other strategic initiatives. Many companies have started large IT projects, such as ERP, CRM and SCM projects, in their effort to revamp their business processes. However, as Prahalad and Krishnan (2002) pointed out, packaged enterprise systems are designed for stability in processes, not ability to evolve. One of the key issues in IT-enabled strategic management is creating an IT infrastructure that offers speed for change and flexibility needed for strategic management.

Understanding how businesses create and sustain competitive value from their investments in IT has been a challenge for strategic management researchers as well as IS researchers. A more comprehensive way of conceptualizing the interplay of IT and strategic management is needed. As more companies are transforming into e-businesses, obviously, information and communication technologies are becoming an integrated part of the organization. However, what is the role of IT in strategic management when computing and network become pervasive and IT becomes invisible? How will emerging IT, such as grid computing, Web services and SOA, change strategic dynamics of organizations? Those questions need to be addressed by both IS and strategic management researchers.

Clearly, the intersection of IT and strategy is ripe for research. Opportunities abound with regard to strategy making and strategy implementation enabled by IT. Research questions falling within the scope of interest could cover a wide range of issues, from various product/market approaches to strategic decision processes to diversification management to corporate governance, to name just a few. For instance, the pursuit of combination, or hybrid, business-level strategies may be more possible now with IT advances. Whereas Porter (1980, 1985) advised organizations generally to pursue one coherent strategy (e.g., the choice between low-cost and differentiation), the advent of flexible manufacturing and highly sophisticated customer database systems may provide more latitude at the business level. A worthy research question is to what extent, and in what contexts, combination forms of competitive advantage can indeed be pursued, and in what ways these strategies are enabled by IT. Likewise, strategic decision processes, such as environmental scanning, analysis and planning, have been aided immensely by the development of executive IS, Internet capabilities and real-time access to business intelligence. These developments enable richer and more abundant information to reach executives, but a key challenge is how to provide relevant information in the proper form and at the right time so the organization can capitalize on opportunities. To what degree might IT advances enable the optimum breadth and depth of information to enter the strategic decision process, given contingencies such as decision makers' characteristics and organizational strategy? These are examples of research questions that would merely begin to scratch the surface.

Conclusion

We have explored concepts and issues involving the use of IT as an enabler for strategic management. We discussed the parallel development of strategic management and IT, and their co-evolutions over the last 5 decades. In general, the theoretical research in strategic management has led the way in the co-evolution. IT and IT-enabled IS are developed to support strategic management needs. The fields are at a unique point in their development, enabling cross-disciplinary research of both practical and theoretical interest dealing with a vast array of organization process and performance issues. We hope the succeeding chapters are helpful in providing a start toward fruitful research agendas and in offering practical guidance to those who are responsible for implementation in organizations.

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Chapter II

Toward a Strategic Perspective of Information Technology

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Abstract

This chapter explores theoretical conceptualizations of IT beyond current common resource-based perspectives, in the hopes that MIS research may benefit from an improved understanding of the role, use, application and alignment of IT with the full spectrum of strategic management's core theoretical perspectives. We argue that research in both fields needs to look at the fundamental value (profit) assumptions, as grounded in strategic management theory, to provide insights into the true role of IT in a firm and its performance. This chapter offers an integrative solution framework to attempt to position IT in the context of some common strategic management theoretical perspectives, which may serve as a basis to assess the validity of future MIS research.

Introduction

Over the years, research in management information systems (MIS) has resulted in significant implications for organizations in a wide variety of areas. As IT-related expenditures can represent a large recurring investment for the firm, the field of strategic management needs to expand its conceptualization of IT beyond current perspectives of a commodity resource. This perspective holds that resources and capabilities acquired in factor markets, such as IT resources, cannot be sources of sustainable competitive advantage (Barney, 1986; Rumelt, 1995). Such *Business Value of IT* research in the MIS field, based upon the resource-based view (RBV) (Barney, 1991; Wernerfelt, 1984) is fairly extensive (e.g., Dewan, Michael & Min, 1998; Hitt & Brynjolfsson, 1996; Melville, Kraemer & Gurbaxani, 2004), and understandably inconclusive. However, work on this topic from a strategic management perspective, where the original theorizing was developed, is extremely limited (Powell & Dent-Micallef, 1997; Ray, Barney & Muhanna, 2004; Tippins & Sohi, 2003). Therefore, business value of IT issues and implications continue to remain underdeveloped and unresolved in the research literature. This has left our understanding of the paradoxical relationship among IT investments, strategy and firm performance far from clear (Berndt & Morrison, 1995; Carr, 2004; Melville et al., 2004; Orlikowski & Barley, 2001; Tippins & Sohi, 2003).

It, therefore, would appear that both the strategy and MIS fields may benefit from an improved perspective of these issues. For example, management theory may benefit from expanding beyond the somewhat rigid conceptualization of IT as a commodity resource. This may include new insights to the positioning and alignment of IT as well as implications for firm performance and competitive advantage. Likewise, MIS research may benefit from an improved understanding of the role, use, application and alignment of IT with strategic management's theoretical perspectives.

As a step towards fostering an exchange of knowledge between the strategy and MIS fields, this chapter reviews some current research perspectives in the MIS and strategy fields, and offers an integrative solution framework for IT. This chapter explores theoretical conceptualizations of IT beyond current common resource perspectives. We argue that IT value research needs to consider explicitly the fundamental value (profit) assumptions, as grounded in strategic management theory, to provide insights into and move beyond the apparent IT value paradox. This chapter proposes an integrative framework to attempt to position IT in the context of some common strategic management theoretical perspectives, which may serve as a basis to assess the validity of future MIS research on IT value. It is our hope that strategy and MIS research both may benefit from a more comprehensive theoretical perspective of the role of IT in the organization.

The Strategy: MIS Intersection

Historically, the strategy and MIS research areas have essentially been mutually exclusive streams, each with their own issues, assumptions and resulting limitations. MIS research has attempted to optimize responses to an assumed managerial issue, often one that strategic management scholars have moved beyond or long since redefined.

Conversely, strategic management scholars, unaware of MIS developments, are challenged to integrate MIS advances and related technologies into their research, models and theories. This problem can create a vicious cycle due to the isolated static concurrent efforts of both fields, each trying to hit a target, without necessarily realizing the other has moved or changed it. For example, why has there been an increase in alliance/joint venture activity since 1990? These forms were well known before this time, yet these transactions really took off in popularity after a specific time. The traditional strategy scholar might note how government antitrust provisions changed, then, to reduce the consideration of these transactions as collusive activities. However, an MIS scholar might note how various IT had developed sufficiently to permit such combinations to occur with greater reliability and reduced implementation costs than previously had been the case.

This issue may also be illustrated through a simplified analogy—MIS tries to improve abilities to support a managerial process, which strategy scholars may have changed or deemphasized due to the lack of an effective IT resource to support an organizational capability. When the new IT resource capability is envisioned or introduced, it may take managers and researchers by surprise, as it may no longer be aligned with their needs or strategies. The technology advancement is often then either ignored if it is too far out of alignment, or acquired and integrated only to a very limited extent if possible. As managers acquire and integrate new IT resources, they may have to realign their activities to create desired organizational capabilities from the IT resource. The likely ensuing "which came first" argument, however, is irrelevant, assuming strategy remains informed of MIS research and/or informs MIS researchers of the strategic needs of organizations. As a step towards fostering an exchange of knowledge between the strategy and MIS fields, this chapter briefly reviews current MIS research motivations and approaches. Then, to explore how IT affects strategy, we provide an overview of the role of IT in strategy and offer suggestions for more effectively grounding IT research in strategic management's theoretical perspectives.

An Overview of the MIS Field and Current Theoretical Motivations

The field of MIS, similar to many developing academic disciplines, has been sometimes criticized over the years as lacking theoretical grounding or its own core theories. Current research efforts in the MIS field tend to fall into two broad areas, based on either a behavioral or analytical focus. The behavioral area of MIS research is loosely grounded in behavioral theories to support the study of human and organizational interaction with technology. The second major research approach, analytical MIS, tends to focus more specifically on the technology itself, and draws from the fields of economics, operations research and computer science.

The inherent nature of MIS is a more pragmatic, practice-oriented discipline. Yet, its use of theoretical models that depend heavily on assumptions that are, at times, incomplete or inconsistent with management practice may be both problematic and a fundamental limitation for the field's evolution, development and maturity. To this extent, this chapter seeks to make a case for the use of pragmatic, cross-disciplinary, practice-oriented theories, such as those utilized in the strategic management field. Such an approach may be a more applicable theoretical base for grounding and motivating research in MIS than some of its current underpinnings in economics, operations research, computer science and human behavior theories.

The MIS body of research on the business value of IT often raises the issue of an IT value paradox in regards to the relationship between IT investment and performance. Some studies find mixed results for the IT investment—performance relationship (Barua, Kriebel, & Mukhopadhyay, 1995; Francalanci & Galal, 1998), while others find negative relationships (Lee & Barua, 1999; Loveman, 1994). Yet other studies find that IT gains might be largely subject to implementation issues (Brynjolfsson & Hitt, 1998; Mooney, Gurbaxani, & Kraemer, 1996). Further, other work suggests that many prior studies may be subject to measurement issues of the IT artifact as well as level-of-analysis issues (Bharadwaj, 2000). Collectively, this body of research paints a perplexing and inconclusive picture as to what the true relationships may be.

Given the size and distance differentials between IT and performance measures at the firm level of analysis (Barua et al., 1995), most recent research is now calling for the study of IT value to focus on the IT-business process relationship (Barua et al., 1995; Melville et al., 2004; Mukhopadhyay, Kekre, & Kalathur, 1995). This issue is largely analogous to the resource—capability—performance relationship, which underlies much of the research on competence-based perspectives of competitive advantage in the strategic management literature. Further, measurement and levels issues are equally of concern in both disciplines (Barua et al., 1995; Drnevich & Shanley, 2005; Ray et al., 2004). Given the importance of the topic, the common issues shared between the research streams and the interdependence of literature, the need for cross-discipline collaboration and coordination is readily apparent.

Overview of Strategic Management's Theoretical Perspectives

As one might expect, given its multi-disciplinary roots and practice focus, theoretical perspectives and influences on strategic management are wide and varied. The ideas contributing to strategy originated in multiple disciplines with different focuses for managerial attention. Key foundational contributions are from economics, finance, sociology and organizational areas of academic inquiry. Economists were interested in a means to explain more effectively the difficulties with traditional and neoclassical models. The application of strategy concepts to economic contexts was done in part to facilitate the scholarly study of the limitations of economic and social theory to real-world organizational and competitive behavior. The concept of strategy in management and economic contexts likewise evolved in part to help managers solve problems and make decisions more effectively. Sociologists were interested in explaining the behavior of the large public and private organizations that emerged in the early 20th century, which spawned the study of bureaucracy and organization theory. Further, psychologists of various sorts were interested in how individuals and groups behaved in these new organizational contexts. These diverse contributory areas provide multiple perspectives from which to study organizations and their strategic behavior.

Strategic management theory does not consist of a fundamental single unified theory, but is made up of evolving, overlapping and sometimes competing theoretical perspectives, each attempting to address and explain elements of the fundamental questions of the field. Recent research by Makadok (2004) offers a useful approach for viewing these various theoretical perspectives in strategic management as a function of four common underlying profit mechanisms. This approach can be used to frame the strategy perspectives by the particular mechanism through which money moves from a customer to the firm and its shareholders, all in the face of competitive pressures, which would normally drive firm profits to zero (Makadok, 2004). This approach classifies strategic management's theoretical perspectives as collusion-, competence-, flexibility- and governance-based theories. The strength of this approach is that it forces one to focus on how any given factor (such as IT) can actually create economic profit for the firm and its shareholders (Makadok, 2004). We utilize this approach to frame a brief overview of strategy's common theoretical perspectives (Table 1 and subsequent discussion). Later, we leverage this framework to offer an integrative framework to position IT in the context of the common strategic management theoretical perspectives.

Collusion-Based Theories

Collusion-based theories evolved from the Bain-Mason *Structural-Conduct-Performance* (S-C-P) paradigm (Bain, 1956, 1959; Mason, 1939, 1949). Collusion-based theories are perhaps most commonly popularized in terms of the "Five Forces" framework (rivalry, buyer power, supplier power, threat of new entrants and threat of substitutes), developed

Table 1. Strategic management's theoretical perspectives

Causal Mechanism	Core Theory	Profit Mechanism	Key Contributors
Collusion	Structure-conduct-performance, I/O economics	Monopoly power rents	Bain, 1956, 1959; Mason, 1939, 1949; Porter, 1980, 1985.
Competence	Resource-based view, Knowledge-based view	Operational efficiency rents	Ricardo, 1817 ; Penrose, 1959 ; Demsetz, 1973, 1974; Lippman & Rumelt, 1982; Wernerfelt, 1984; Barney, 1986, 1991; Kogut & Zander, 1992; Peteraf, 1993
Flexibility	Dynamic capabilities, real options	Flexibility rents	Schumpeter, 1934, 1950; Teece, Pisano & Shuen 1997; Dixit & Pindyck, 1994; Kogut 1991; Kogut & Kulkani 1994; McGrath 1997.
Governance	Transaction cost economics, agency theory	Transactional efficiency rents	Coase 1937; Alchian & Demsetz 1972; Williamson, 1975; Jensen & Meckling 1976.

See Makadok 2004 for more detail on the "Four Theories of Profit" by Michael Porter (1980, 1985), and is still commonly taught as one of the dominant strategy perspectives by business schools. This perspective views competition as a *cooperative game* within the industry and an *adversarial game* with firms outside the industry group (Makadok, 2004). The economic profit mechanism in collusion-based theory is "Banian" monopoly power rents (Bain, 1956, 1959), and the causal mechanism for superior profitability is *tacit collusion* to avoid rivalry among input and output factors of the industry, while maintaining barriers to prevent others from entering the industry (Makadok, 2004; Porter, 1980).

This perspective views strategy as a portfolio of businesses and focuses on market positioning, optimizing strategy for an industry and establishing and defending a monopoly or oligopoly position. Key concepts include industry attractiveness, physical asset bases and leveraging market imperfections. The level of analysis is generally viewed as the strategic business unit. Faults may lie in sub-optimization of firm level performance through this focus. Criticism often revolves around the static nature of the approach and its limited applicability to less stable and fast cycle-time markets and industries. More recent research (Makadok, 2004) advocates that the theoretical relationship between firm rivalry and aggregate industry profit in this perspective may be incorrect for firms with large differences in competencies.

Competence-Based Theories

Competence-based theoretical perspectives evolved more recently, but can trace their roots back to Ricardo's (1817) arguments on resource scarcity, Penrose's (1959) theory of firm growth and Demsetz's (1973, 1974) arguments against the S-C-P paradigm (Makadok, 2004). The perspective was developed in the 1980s as the *Resource-Based View* (RBV) of the firm (Lippman & Rumelt, 1982; Wernerfelt, 1984), but was not popularized until the 1990s (Barney, 1991; Peteraf, 1993). RBV has become one of the dominant strategy perspectives taught by business schools and is currently perhaps the most popular, and heavily cited, among scholars within and beyond the strategy field. It is also the dominate perspective on which MIS scholars generally rely to ground and motivate most business value of IT research (Melville et al., 2004).

The perspective views competition as an *adversarial game* among all firms within as well as outside of the industry (Makadok, 2004). The economic profit mechanism in competence-based theory is "Ricardian" operational efficiency rents (Ricardo, 1817), and the causal mechanism for superior profitability is *exploitation* of resource inputs to create competitive advantage and superior profitability (Barney, 1991; Makadok, 2004). Competence-based theories include RBV, as well as the knowledge-based view (KBV) and the Dynamic Capabilities (DC) perspective (Teece, Pisano, & Shuen, 1997). The first two views will be discussed in this section and in detail throughout this chapter, while the latter has closer ties with flexibility perspectives than to its roots as a competence perspective, and as such, will be discussed as part of that perspective.

The Resource-Based View

The RBV of strategy (Barney, 1991; Wernerfelt, 1984) considers the firm as a portfolio of resources and capabilities. The lens and level of analysis in RBV is at the level of the firm and the focus of the perspective is with what the firm should compete (resources and capabilities). This perspective advocates the source of competitive advantage as primarily internal (unique resources and capabilities), and views competitive advantage as survivability. Further, RBV assumes that firms are collections of unique resources and capabilities endowed or acquired over time, that these provide the primary basis for a firm's strategy and profitability, that these resources are not highly mobile across firms, and that differences in resources may exist between firms over the long term (Barney, 1991; Wernerfelt, 1984). If these resources are valuable, rare, imperfectly imitable and can be well organized, they may be utilized as capabilities in the attempt to create a sustainable competitive advantage and achieve superior profitability (Barney, 1991; Grant, 1991).

The Knowledge-Based View

One prominent resource underlying firm capability is knowledge. The KBV evolved from Kogut and Zander's (1992) work on knowledge as a source of competitive advantage and possible foundation for a theory of the firm. This view advocates that firms are more effective than markets at the creation and transfer of knowledge. Valuable competitive knowledge, in this perspective, is viewed to exist at the individual level and embedded in the organization in a path-dependent manner, and knowledge creation is based upon a recombination and replication of existing knowledge within the firm (Grant, 1996; Kogut & Zander, 1992). KBV further developed as Grant (1996) conceptualized the firm as an institution for integrating knowledge. This differed from prior work by Kogut and Zander (1992) in asserting that the domain of the organization is knowledge application (and coordination), as opposed to knowledge creation. Organizational capabilities to integrate and coordinate knowledge, therefore, are viewed as essential to achieve and maintain a competitive advantage.

Flexibility-Based Theories

Flexibility-based perspectives evolved from Schumpeter's (1934, 1950) concept of *creative destruction*. These perspectives view competition as a *game against nature* rather than among firms, where the firm is forced to respond and adapt to the effects of the exogenous environment (Makadok, 2004). The economic profit mechanism in flexibility-based theories is "Schumpeterian" flexibility rents (Schumpeter, 1934, 1950), and the causal mechanism for superior profitability is effectively to allocate firm resources and capabilities to market opportunities on an ongoing basis to create temporary competitive advantages and superior profitability (Makadok, 2004; Teece, Pisano, & Shuen, 1997). This perspective is made of several diverse operationalizations in strategic management. These include evolutionary views of firm behavior and routines (Nelson & Winter, 1982), dynamic capabilities (Teece, Pisano, & Shuen, 1997) and real options (Dixit & Pindyck, 1994).

Dynamic Capabilities

Concerns over the potentially static nature of RBV and debate over the delineation and attention between resources and capabilities in part motivates a related perspective focused on DC. The concept of DC refers to a firm's abilities to maintain and adapt the internal capabilities that are the source of its competitive advantage to market and environmental changes in order to maintain sustainability of competitive advantage (Teece, Pisano, & Shuen 1997). This concept involves continuous search, innovation and adaptation of firm resources and capabilities to take advantage of new and emergent market opportunities to uncover and tap new sources of competitive advantage. With this perspective, competitive advantage isn't necessarily sustained, it more or less evolves, and resources are recombined and shifted to new opportunities as advantages dissipate.

Real Options

Real options is a concept borrowed from finance and applied in theory to the context of managerial decision-making. The concept refers to the right to enter into a transaction, engage in an activity or acquire a desired asset or position at some point in the future. It may represent an alternative to traditional investment appraisal techniques (i.e., net present value), particularly for technology decisions and MIS applications, as they are more effective at dealing with issues of uncertainty.

The applications of real options logic or thinking to the domain of strategic management has been a hot interest area as of late, and the development of real options theory has progressed mostly unabated until recently. The application of the real options concept to strategy developed throughout the 1990s by work from Kogut (1991) and Kogut and Kulkani (1994), which highlighted the firm's ability to influence boundary conditions and uncertainty that may affect both firm capability development and option value. Some debate is based on the bounds of real options as they are applied to strategy contexts (Adner & Levinthal, 2004). As Adner and Levinthal (2004) see it, if a firm can influence the underlying uncertainty, an option will be difficult to structure and value ex ante. Further, unforeseen opportunities arising from this unspecificable uncertainty (combined with generally accepted notions of firm behavior) complicate the firm's ability to know when to abandon an option, which limits the flexibility the option was designed to provide. These implications do not imply that real options logic is not useful in strategic management contexts, but do suggest that the usefulness of real options in some applications may be bounded. Unfortunately (or fortunately?), the boundary limits and conditions of the application of real options to strategic management contexts are far from clear.

Yet, real options may also be viewed as a type of "insurance" against the accumulation of sunk costs in specific assets with path-dependent implications by allowing the firm to defer investment decisions until uncertainties are resolved, such as clarifying market, resource and competitive positions. As this example may indicate, the use of real-options thinking may be particularly beneficial to MIS topics. This logic allows the firm option to extend, expand, delay or cancel an option position. Limitations, however, may exist in the operationalization and implementation of the concepts to managerial practice, given numerous ancillary limitations, which could be associated with technology investments.

Governance-Based Theories

Governance-based perspectives evolved from the work of Coase (1937), and were built upon later by Williamson (1975), Alchian and Demsetz (1972), and Jensen and Meckling (1976). These perspectives view competition as a *cooperative game* among transactional partners who include suppliers, customers, management, employees, shareholders and investors (Makadok, 2004; Williamson, 1975). The economic profit mechanism in governance-based theories is "Coaseian" transactional efficiency rents (Coase, 1937), and the causal mechanism for superior profitability is the efficient allocation of *decision rights* and *incentives* to create superior economic value (Jensen & Meckling, 1976; Makadok, 2004; Williamson, 1975). This perspective is perhaps best known for its areas of transaction cost economics (TCE) (Williamson, 1975) and agency theory (Jensen & Meckling, 1976), which represent fundamental theoretical foundations within and beyond the field of strategic management.

Transaction Cost Economics

The origins of TCE evolved from earlier work on the nature of the firm (Coase, 1937), which introduced a theory that firms exists because it is costly to use the price system alone to coordinate economic activity solely in the marketplace. TCE advocates markets and firms as alternative ways of organizing economic activity and uses a positive orientation and inductive methods to study economic activity through the transaction as the unit of analysis to attempt to explain why firms exist. This theory views firms as alternatives to markets, which only exist when markets fail to function efficiently (Williamson, 1975). Issues associated with TCE include uncertainty, complexity, asset specificity and opportunism. The principle argument in TCE is the distinction between the efficiency of firms and markets. Firms are argued to be more efficient than markets only when specific assets, imperfect information and a small number of transactions are present in the market (Williamson, 1975).

Agency Theory

Agency theory was derived from work by Jensen and Meckling (1976) to explain the idea that managers (agents) are not simple utility maximizers but are boundedly rational and may act opportunistically. This work defined an agency relationship as a contract under which a principal contracts with another person (agent) to perform a service, which involves delegating decision-making authority to the agent. Agency theory is closely related to TCE. It differs mainly on the unit of analysis and assumptions of firms and market efficiency. Specifically, agency theory utilizes the relationship or contract between principal and agent as the unit of analysis, and assumes firms more efficient than markets. In comparison to TCE, agency theory focuses on monitoring the transaction, while TCE focuses on governance of the transaction. As such, agency theory is commonly used to examine more specific, lower-level relationships.

Agency theory involves examining the relationships between managers (agents) and owners (principals) of organizations. The concept of divergent goals between principals and agents is a central premise of agency theory. In relation to strategy, it is fairly accepted that agency theory makes two specific contributions (Eisenhardt, 1989): First, it regards information as a commodity that has a cost and can be purchased. Second, agency theory extends strategic thinking by viewing uncertainty in terms of the risk/reward trade-off. Agency problems are also especially relevant in financing, acquisition and divestiture decisions (Eisenhardt, 1989). Finally, the limitations of TCE may be also be equally applicable to agency theory, where common criticisms are that it only explains a part of the firm's existence and is excessively narrow, with few testable implications (Perrow, 1986).

Issues, Controversies, Problems

Unfortunately, the major theoretical perspectives in strategy discussed in this chapter are somewhat challenged in their ability to handle the role and implications of IT. While the resource-based view of the firm is perhaps the most frequently leveraged perspective to ground research on IT value, it appears to be the least understood and most incorrectly applied theoretical perspective. Other competency-based perspectives may also offer effective bases for grounding IT research; however, they are not without their limitations in conceptualizing the role of IT in the firm, as well. In this section, we offer an overview of some of the issues, controversies and problems of the major strategic management theoretical perspectives in relation to how they conceptualize and treat the role of IT.

In terms of strategic management theory, tension continues to exist in the literature as to the role and value of IT to the organization. Theoretical perspectives from the strategy literature are far from clear as to the role and implications of IT on the firm. Governance perspectives, such as TCE (Williamson, 1975), may support the value of IT in terms of its ability to reduce transaction costs within and between organizations. However, competence perspectives, such as the common RBV (Barney, 1986, 1991; Wernerfelt, 1984), would tend to categorize IT as a simple resource. As IT is usually developed exogenously and then purchased or leased by the firm, IT in itself is not rare, non-substitutable nor excessively costly to imitate, and therefore, should be theoretically incapable of contributing to firm-level competitive advantage, as suggested by RBV (Barney, 1986, 1991; Rumelt, 1995). This highlights a substantial common flaw in the theoretical grounding of much MIS research on the business value of IT.

Yet, how the RBV would treat IT resources and their integration with concept of organizational capabilities to enable a new capability for the organization (*IT-Enabled Capability*) is less clear. This may be a phenomena of interest, particularly in light of recent work (Lippman & Rumelt, 2003), advocating that competitive advantage may be really only attributable to the resource level, not the firm level. This conceptualization may find further support in the KBV (Grant, 1996; Kogut & Zander, 1992), which could conceivably view IT as a capability enabler or enhancer that, if effectively implemented and integrated, may improve the organization's knowledge gathering, recombination and deployment capabilities. These issues, conflicts and problems clearly indicate that the tension among strategy's theoretical perspectives on the role and value of IT on firm performance is in need of substantial further exploration. The next section proposes a potential solution framework, which may assist scholars with positioning, aligning and grounding IT more effectively with strategic management's theoretical perspectives.

Solutions and Recommendations

As discussed earlier, currently, strategic management theory does not have an effective means of conceptualizing IT or its contribution to the firm. Likewise, MIS literature on the business value of IT does not as yet have an effective basis to ground their approaches in the theoretical mechanisms necessary to effectively conceptualize, model and examine the IT-performance relationship. Resolving these issues requires substantial additional work in both disciplines for theory to first be developed and then effectively applied to future research. To obtain a clearer perspective for theory, we need to specifically determine what role IT should play in the firm. If we briefly ponder this question, we quickly obtain many possible answers. These include: Is IT a resource?; a means of supporting and/or enhancing current organizational capabilities?; a basis for new capability creation?; an infrastructure for the firm?; a means of communication within and beyond the firm?; a distribution channel for products?; all of the above?; or something else altogether? Further, even if IT itself can be accurately conceptualized and measured from each perspective, how do we effectively conceptualize, define and measure IT's performance contributions from each perspective?

Unfortunately, IT research, from a strong strategic management theoretical perspective, is extremely limited, potentially due to the previously discussed common perception among strategy theorists of IT as a commodity resource (Barney, 1986; Rumelt, 1995). Conversely, while the study of the role of IT in organizational performance is much more prevalent in the MIS field (see Melville et al., 2004), this vast body of this work often suffers from a narrow and limited view of strategic management theory. Much of the MIS work on this topic operates from a paradigm grounded in a narrow segment of competence-based theory (i.e., Barney's (1991) conceptualization of Wernerfelt's (1984) resource-based view). Therefore, business value of IT work as a whole is limited by such perspectives. Therefore, we argue that both strategic management and MIS could benefit substantially by a consideration of how the fundamental theoretical perspectives of strategy (i.e., collusion-, competence-, flexibility- and governance-based perspectives) may influence the role of IT on the firm. This should help address the interesting issue

Table 2. The roles of IT in strategy

1. IT as a resource?
2. IT as a means of supporting and/or enhancing current organizational capabilities?
3. IT as a basis for enabling new capability creation?
4. IT as infrastructure for the firm?
5. IT as a means of communication within and beyond the firm?
6. IT as a distribution channel for products?
7. Is IT all of these, or something else altogether?

of how different technologies vary in their strategic applications. However, we still have to consider the issue of how to conceptualize and frame IT across multiple levels of analysis within and beyond the firm.

Multi-Level Implications of IT-Enabled Strategy

Recent work (Drnevich & Shanley, 2005) introduces the concept of strategy's problem-focused, multi-level nature. This entails that strategy research topics, with few exceptions, tend to be problem-focused and complex. Most of these issues are inherently multi-level, and a firm's capabilities are often focused largely on operating effectively in these broad multi-level environments. Strategic research topics, as such, naturally span multiple levels of analysis whether or not they realize it. Therefore, crossing of levels of analysis is fundamental to the field of strategy and especially to ideas of complexity, commitment and sustainability of the firm.

An effective strategy, therefore, must have a means of linking or spanning the levels. Three mechanisms, grounded in the strategic management literature, may be effectively utilized to attempt to address multi-level issues. These mechanisms include using transactional and contractual approaches, using the role of the manager and/or using a common context, atmosphere or shared organizational culture to span levels (see Drnevich & Shanley, 2005). These suggested approaches to linking levels have relative advantages and disadvantages depending upon various circumstances, and no one approach is necessarily most effective. For example, transactional approaches are better for modeling, but are more abstract in dealing with the "richness" of actual situations. However, while firm activities and behaviors may aggregate well to macro levels of analysis, many phenomena may simply not be effectively captured through contracts. Conversely, focusing solely on the role of the manager as the means of spanning levels may better reflect the fluidity of most situations, yet they may also be far less suitable for modeling (Drnevich & Shanley, 2005).

Therefore, without such a multilevel perspective of strategy, the relationship of IT to resource, capability, firm, industry and environment/market levels simply results in a contingency theory that would offer general relationships of fit and misfit. However, if you merely inaccurately or ineffectively incorporate strategy perspectives, you simply introduce the issue of firm-level variation, which just "muddies the water" for a useful contingency theory. Thus, to develop a framework to relate IT with strategy, we start with a central dyad between MIS and strategy, the area of the business value of IT, and discuss the basic issue interfaces. We then add the levels perspective (resource, capability, firm, industry and environment/market) as influences on the particular issues between MIS and strategy that are important. This process should help address the interesting issue of how different technologies vary in their strategic applications. This solution framework is depicted in Table 3, and discussed in more detail in the remainder of this section.

Table 3. A strategic perspective of the role of IT

Causal Mechanism	Core Theory	Profit Mechanism	Role of IT
Collusion	SCP, IO economics	Monopoly power rents	• Resource Level • Information acquisition and communication • Capability Level • IT-enhanced or -enabled bargaining power over buyers • IT-enhanced or -enabled bargaining power over suppliers • Firm Level • IT-enhanced or -enabled operational efficiency • IT-enhanced or -enabled differentiation from competition • Industry Level • IT-enhanced entry barriers • IT-enhanced exit barriers
Competence	RBV, KBV	Operational efficiency rents	• Resource Level • Knowledge acquisition and transfer • Capability Level • IT-enhanced or -enabled knowledge application • Firm Level • IT-enhanced or -enabled competitive competences • Industry Level • IT-enhanced or -enabled competitive context
Flexibility	DC, RO	Flexibility rents	• Resource Level • Information processing and communication • Capability Level • IT-enhanced or -enabled dynamic flexibility • Firm Level • IT-enhanced or -enabled strategic alignment • Industry Level • IT-enabled communication networks • IT-enabled strategic alliances
Governance	TCE, agency	Transactional efficiency rents	• Resource Level • Information processing and monitoring • Capability Level • IT-enhanced or -enabled sourcing • IT-enhanced or -enabled contracting • Firm Level • IT-enhanced or -enabled corporate governance • Industry Level • IT-enabled exchange mechanisms

IT-Enabled Collusion

A collusion-based perspective of IT might focus on how IT could help the firm obtain and process information on the marketplace. This may include information and systems for dealing with both buyers and suppliers to increase the firm's power in these relationships. This may also include systems for monitoring a firm's competitors. However, the largest role for IT may be at the firm level as sources of production or operational efficiency. Such IT-enabled operational efficiencies may help a firm operate at lower costs than its rivals. This may, in turn, serve as a source of advantage for the firm, which would allow it a larger margin than its rivals at an equal pricing level. Similarly, IT may also potentially serve as a source of differentiation for the firm. Such IT-enabled differentiation may potentially provide a source of advantage for the firm, which could allow it to under-price its rivals and earn larger margins.

Additionally, IT investments at various levels, or across levels, may potentially serve as barriers to entry or exit for an industry. For example, if an industry requires a substantial investment in IT resources, and a substantial ongoing investment to build and maintain IT capabilities, this may serve as an obstacle to other firms from entering an industry. Likewise, if an incumbent firm has a substantial sunk cost investment in industry necessitated asset-specific IT resources and capabilities, this may serve as an impediment to exiting an industry. For example, a firm in the telecommunications business may leverage IT to develop a lower-cost position or higher-quality product to offer the market. The size of such a required investment may prevent others from entering the market and challenge the firms already in the market. Yet, the size of the asset-specific IT investments prevents the firms from being able to utilize the asset for other purposes. The firm, therefore, is unable to leave the industry and, as such, unwilling to create rivalry with other firms in the industry that could undermine its profitability.

IT-Enabled Competence

A competence-based perspective of IT is perhaps the most intuitive and commonly observed, though, as argued earlier, often the most problematic and incomplete. This perspective would likely consider IT as both a resource and a capability. As such, an IT resource to acquire new external knowledge, to uncover internal knowledge and/or to recombine internal and external knowledge, and then apply this knowledge to opportunities, may potentially serve as a means of advantage to the firm. However, this may only be effective so long as the knowledge is valuable, the resulting product non-substitutable and the collective competency causally ambiguous to avoid imitation by competitors and, hence, erosion of the advantage.

Collectively, from a competence-based perspective, IT may also serve as infrastructure for an industry, as in the case of the Internet. In this and similar manners, IT may be thought of as a competitive context. In this sense, IT is not so much a source of advantage, but more a price of admission, a strategic necessity. IT resource and capability investments under these circumstances do not offer opportunities for competitive advantage to a firm per se; however, the absence of an IT investment would place the firm at an extreme competitive disadvantage (Mata et al., 1995). All of these roles for IT clearly rely on a strict conceptual separation of resources and capabilities, which remains theoretically problematic for the RBV. Specifically, the RBV would clearly suggest treating IT first as a resource, but the fact that IT systems are purchased and/or IT capabilities can be leased and developed external to the firm might suggest issues of low uniqueness (Barney, 1986; Rumelt, 1995). This further suggests that, to support a competitive advantage, how the IT resource fits into the firm to enable a strategy may itself be considered a resource-based capability. However, for this to be the case, we would need to distinguish the IT resource from its management, application and integration with the firm's activities ("IT enablement," per se). That itself raises the interesting issue of how different technologies may vary in their strategic applications.

Fortunately, some of these issues may be attributable in part to limited operationalization of the RBV, which does not clearly distinguish between resources and capabilities. Such difficulties clearly exist in viewing IT as a capability prior to its integration in the firm and alignment with organizational capabilities. This need for a distinction between IT as a resource and IT as a capability enabler is likely because the mere presence of an IT functionality within the firm does not convey the existence of the organizational capability it was designed to support, nor the associated business process competence (Tippins & Sohi, 2003).

However, such a distinction between resources and capabilities may already exist to some extent in the knowledge-based view (Grant, 1996; Kogut & Zander, 1992), which offers a clearer distinction more in line with Penrose's (1959) original conceptualization of the distinction between resources and services. In the KBV, there are two aspects of all knowledge, tacit and explicit (Polanyi, 1958, 1966); and tacit individual and/or organizational knowledge may serve as a competitive resource (Grant, 1996; Kogut & Zander, 1992). This would imply that if firms are competing on their tacit knowledge resources, then IT-enabled capabilities for acquiring, applying and managing this knowledge could themselves contribute to competitive advantage. Further, such knowledge embedded in firm-specific assets and routines may also be of critical importance to firm performance (Barney, 1986, 1991; Nelson & Winter, 1982). Therefore, from a KBV perspective, firm-specific investments in IT may also be a source of value creating knowledge capabilities (Poppo & Zenger, 1998).

These issues indicate that a clearer distinction between IT resources and IT-enabled capabilities is still needed for competency-based perspectives to understand and explain the role of IT in the firm. This approach is also supported by recent work, which advocates that the contribution potential of external resources is likely limited to their ability to enrich or reconfigure a firm's preexisting internal resources and capabilities (Branzei & Thornhill, 2004; Montealegre, 2002; Schroeder, Bates, & Junttila, 2002). Adding clarity to this issue may offer one means of improving our collective abilities to explore and perhaps actually measure the business value of IT from a competence perspective.

IT-Enabled Flexibility

Flexibility-based perspectives are generally based on DC (Teece et al., 1997) or real options (Dixit & Pindyck, 1994)—response approaches to evolutionary change in the firm's environment, market or competitive contexts. Flexibility-based approaches of IT might focus on how IT can enable the firm to monitor and adapt to its environment. This might include information services to provide the firm with market and competitor intelligence, as well as IT systems for processing and analyzing such information. Further, IT may also be employed to enable dynamic or flexible capabilities to allow the firm to reconfigure products and services to adapt to changes in the marketplace (Galunic & Rodan, 1998). This could also include the firm maintaining option positions in new technologies and markets as well as options to access related resources and capabilities in the future, should they be required. IT-enabled flexibility may also involve highly automated, flexible manufacturing and operating systems, which allow a firm to re-align its strategy and quickly reconfigure its activities to apply to new competitive opportunities. At an industry level, this may also include IT mechanisms for forming alliances and networks, as well as communicating.

IT-Enabled Governance

Governance-based perspectives are based on issues of efficiency, which focus on the firm's boundary, and issues of market vs. hierarchy structures for coordinating a firm's activities (Coase, 1937; Williamson, 1975). IT systems from this perspective may focus on how a firm may manage or contract for activities, and then monitor these relationships. A governance-based perspective of IT might focus on how IT may enable a firm to more effectively source inputs required for its operations (human resources, raw materials, knowledge, etc.). IT may also be used to enable new monitoring and processing capabilities within the organization. By moving such activities "online," this may also enable the firm to contract for these capabilities from the market (outsourcing). IT may also provide a means for a firm to monitor and govern all of its operations (i.e., as in the case of modern financial systems, enterprise resource planning systems, HRM systems, workflow management systems, etc.). Further, IT may also serve as the marketplace or exchange mechanism for sourcing, outsourcing and distribution for the firm (as is the case with the Internet, business-to-business exchanges, etc.). This theoretical perspective, while historically one of the most leveraged in traditional strategy research, is fairly under-leveraged for IT research and, as such, perhaps holds some promise for use in future research.

Conclusion and Future Trends

A goal of this chapter was to help inform MIS research of strategic management's theoretical perspectives as well as inform strategic management scholars of the potential business value of IT. Specifically, a major premise is that MIS research might benefit from an improved understanding of the role, use, application and alignment of IT with an organization's strategic perspective(s). Likewise, strategic management scholars could benefit from being informed of MIS research on the business value of IT, which may hold implications for firm performance.

Future research on a strategic perspective of IT value is clearly needed to continue to explore and measure the resource functionality—organizational capability—firm performance relationship. Specifically, IT resources, when aligned with organizational processes and competencies, may produce organizational capabilities, which, when directed toward suitable market opportunities, may potentially result in superior firm performance. Future research is needed in both the MIS and strategy fields to examine these implications. A few of the prominent, largely un- or under- explored and unanswered questions we see include: How does IT affect firm boundaries?; How do IT resources contribute to organizational capabilities and firm performance?; Under what conditions

Table 4. Strategy/MIS research questions of interest

1. How does IT affect firm boundaries?
2. How do IT resources contribute to organizational capabilities and firm performance?
3. Under what conditions do certain IT resources contribute more effectively?
4. Why do firms invest in IT resources and capabilities?
5. What perspective(s) do firms ascribe to when they make IT investment decisions?
6. How do firms attempt to realize the benefits of IT resources and capabilities?
7. What approaches to benefits realization may be most effective and why?

do certain IT resources contribute more effectively to organizational capabilities and firm performance?; Why do firms invest in IT resources and capabilities?; What perspective(s) do firms ascribe to when they make IT investment decisions?; How do firms attempt to realize the benefits of IT resources and capabilities?; What approaches to benefits realization may be most effective and why? These are depicted in Table 4.

Additionally, we should recognize that researchers might have to adopt different perspectives at different times and/or in different markets, as well as adopt multiple perspectives. Major issues with this are the implications arising from interactions of the perspectives. While some interactions may potentially be synergistic and additive (i.e., competency and flexibility, perhaps) other interactions may be negative (i.e., competence and collusion, perhaps) (Maddox, 2004). The implications of such interactions may create substantial challenges for research on IT business value. The challenge, then, for researchers is in effectively drawing upon these multiple theoretical perspectives to accurately identify the true combinations of technology resources, organizational capabilities and market opportunities that may drive sustainable competitive advantage for the firm. Research designs, variables, measures, sample selection and analytical methods will need to consider, address and control for these issues and implications. The research objective, then, becomes one of crafting MIS research to refine the technology resources and optimizing IT capabilities, as well as to craft aligned multi-level strategies that focus IT resources on firm capabilities and market opportunities for firms to compete most effectively.

Further implications for MIS research include understanding that the keys to success for a firm and its strategy are quite complex. For research to be useful and practical, important issues, such as market structure, human capital and how firms and consumers perceive and use new technologies, likely need to be taken into greater consideration. As we have argued in this chapter, if IT functionality does not match or align with a means of generating economic profit for the firm, as is often the case, it is incapable of providing any business value. As such, IT may not matter in many or most implementations and, therefore, may have a neutral or negative relationship with firm performance, as some propose (Carr, 2004; Mata et al., 1995).

Therefore, ongoing attempts to study and measure IT value will continue to be ineffective if alignment with the firms' underlying competitive causal and profit mechanisms is not taken into consideration. Clarification and significant further work is clearly needed to measure and examine the relationship among IT resource functionality, organizational capability and firm performance, as well as a host of other issues and implications IT may hold for organizations. Future research needs to be explicit about the underlying theoretical perspective(s) when conducting IT value research. This chapter offers an approach for assessing the validity of IT strategy research. Essentially, empirical research on the business value of IT should make sure it takes into account and is aligned with the competitive causal and profit mechanism(s) of its data sample, and should seek to examine how, where, when and under what circumstances IT may affect the firm. We hope that this chapter may serve as an initial contribution to motivate and more effectively ground such work.

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Chapter III

IT Portfolio Management: Implementing and Maintaining IT Strategic Alignment

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Abstract

Information Technology Portfolio Management (ITPM) is a topic of intense interest in the strategic management of IT. In ITPM, IT synchronization with corporate business strategy is operationalized by the application of the principles of financial portfolio management to IT investments. This perspective is crucial to the continual alignment of business strategy and IT investments. Portfolio management is the discipline of managing projects together as a portfolio that meets stated corporate goals and objectives (Combe & Githens, 1999). It facilitates the optimization of resource allocation and development investment across multiple projects. This chapter investigates current techniques and issues for managing IT project portfolios and aligning those portfolios with the strategy of the business. The models and concepts presented are regarded as a starting point for dialogue and further research among IT project researchers and practitioners.

Introduction

Projects are used by companies to convert corporate strategy into new services, processes and products needed for the success and viability of the organization (Benko & McFarlan, 2003). Selecting the right projects through which to implement corporate strategy is a critically important process. Yet, selecting projects that support corporate strategy is often cited as an area of extreme weakness in many organizations. This misalignment of strategic planning and tactical operations is particularly acute in many IT organizations today (Bonham, 2005).

According to Rosser (2001), the IT portfolio approach suggests that alignment occurs in three ways. By definition, this approach forces engagement between the business and IT. It raises that engagement from a typically myopic review of individual projects to a more complete review that looks across all projects in the context of a comprehensive business strategy. Finally, the IT portfolio approach greatly reduces the emotional aspects of the project prioritization discussion and replaces it with criteria grounded in the business strategy.

ITPM is becoming an indispensable communication tool that helps business executives understand the visible impact IT operations have on business performance (Archibald, 2003). An IT portfolio is a set of managed technology assets, process investments, human capital assets and project investments allocated to business strategies according to an optimal mix based on assumptions about future performance (Benko & McFarlan, 2003). One of the goals of ITPM is to maximize value and risk tradeoffs in optimizing the organization's return on investment (ROI).

Under ITPM, all of an organization's IT projects are placed in a single repository, where the risk and reward of each project is reviewed and quantified. Using these metrics, senior management can then prioritize each project.

Portfolio management is not a new concept for business and IT organizations (Jeffery & Leliveld, 2004). However, in many organizations, portfolio management is typically used as a metaphor for prioritizing projects (Cooper, Edgett, & Kleinschmidt, 1998). Project portfolio management offers much more to the organization than simple project prioritization. Many of the financial analysis tools that financial portfolio managers utilize can be directly applied to the management of IT investments in infrastructure, applications, hardware, people, information, processes and projects. These analytic tools provide a view of investment alternatives based on cost vs. return and link IT investment decisions to business goals and objectives.

ITPM is important because most organizations have more project ideas than they have physical or financial resources to carry them out (Archer & Ghasemzadeh, 1999). In a similar vein, Cooper, Edgett and Kleinschmidt (2000, p. 19) write: "Pipeline gridlock plagues many IT portfolios. There are simply too many projects and not enough resources to do them well." Anell and Jensen (1998) observed that in-house projects have a tendency to make themselves permanent and that even failed projects show a surprising capacity for survival in many organizations. Existing models of ITPM are designed to help address this project overpopulation problem. However, some authors argue that this is only one side of a two-sided coin, of which the other side involves the active cultivation and nurturing of potential projects before they enter the traditional project portfolio management framework. A similar paradigm shift has taken place in the literature on risk management, in which the traditional view was that all risks are detrimental to projects. Now, the balance of opinion has shifted to acknowledge risk as a source of positive opportunities as well as negative effects (Charette, 2002).

Projects and potential projects typically pass through many stages of screening and prioritization before they are approved. For example, project portfolio management theory determines well-defined project checkpoints (or gates) where projects can be formally or informally challenged against established criteria. These checkpoints are used to determine if a project should be continued, accelerated, put on hold or canceled in the light of changing circumstances. Recent ITPM literature reveals that in many businesses this process is frequently less systematic and less rigorously enforced than portrayed in the models. As a consequence, many organizations are placing an increased emphasis on methodologies and processes that serve to better align projects with business strategy (Artto, Martinsuo, & Aalto, 2001). This disconnection between the corporate strategic direction and the portfolio of projects that will bring that strategy to fruition remains a deep source of concern to many chief executives today (Combe, 1998; Junttila, Ekholm, & Matilainen, 2001; Sharpe & Keelin, 1998).

To contribute to this dialogue and work towards achieving full economic benefit from ITPM, this chapter presents models, issues and best practices as well as published portfolio theories and case studies. ITPM is a relatively young discipline and the material presented is intended to serve as a starting point to promote dialogue, participation and further research. The chapter begins with an exploration of the current research on ITPM and motivations for the increased interest in ITPM today. The focus then moves to a discussion of the importance of aligning IT and business strategies and the importance of evaluating IT investments to ensure that those investments are aligned with one or more business strategies. From here, the chapter explores best practices and issues surrounding construction of the IT portfolio plan and associated IT portfolio. Next, an examination of IT portfolio, project and asset management issues and strategies is presented. The next section of the chapter delves into IT portfolio assessment and explores portfolio management techniques that help ensure that the IT portfolio is continually aligned with the strategy of the business. A discussion of the issues and strategies surrounding the effective communication and governance of the IT portfolio as well as a brief discussion of future trends in ITPM round out the chapter.

Background

The product of the strategic planning process in most organizations is the strategic plan. However, the strategic process remains unrealized without proper implementation. Project management was defined by Turner (1996) as the art and science of converting vision into reality. This definition highlights the strength of the relationship between strategy creation, project management and strategy implementation. It is the confluence of these disciplines that has evolved into the modern science of project portfolio management. A literature review on project portfolio management by Poskela, Korpi-Filppula, Mattila and Salkari (2001) presents a hierarchical relationship between strategy, project portfolio and individual projects. Referring to authors such as Archer and Ghasemzadeh (1999), Anell and Jensen (1998) and Turner (1999), they describe the role and purpose of project portfolio management as (1) a tool to implement the organization strategy; (2) a process for the projectification of business strategy; (3) a means to balance overall risk; and (4) a tool for optimizing resource allocation across projects.

Although relatively young as a discipline, ITPM has greatly matured in the last few years (Martinsuo, 2001). The number of organizations exploring ITPM as a way of adding value to their bottom line continues to grow each year, with projects increasingly viewed as "building blocks" in the design and execution of strategy (Project Management Institute, 2000). Sommer (1998) argues that any organization that funds, manages and allocates resources to more than one project has by definition a project portfolio (whether the organization is aware of it or actively manages it). Martinsuo (2001, p. 43) supports this view, stating, "Many project firms have succeeded probably without ever knowing that they manage a portfolio."

ITPM has been utilized by leading companies to make their enterprises more agile and competitive. Rather than locking in an annual budget, companies can create one list of necessary operating expenditures. They can then devote the rest of their money to an IT venture fund, the money from which can be shifted rapidly as opportunities arise and change. Portfolio management changes IT strategy from the old reactive paradigm to a sense-and-respond model of operation. As a result, ITPM theory, techniques and best practices are emerging areas of interest to IT researchers and industry leaders today (Combe & Githens, 1999).

Companies that become industry leaders share a common trait—they understand and exploit their specific source of value to customers. The strategy of these companies emphasizes excellence and prioritizes IT investments according to one of three value disciplines: product leadership, customer intimacy or operational excellence. Treacy and Wiersema (1995) argue that no company can be all things to all people. The company must identify a unique value that it alone can deliver to a chosen market by being dominant within one of these value disciplines.

Treacy and Wiersema (1995) crafted a simple but effective framework to guide strategic planning and help manage the IT investment portfolio of companies. Leadership in each of these disciplines delivers different types of value to customers, thereby requiring different types of IT investment unique to that value discipline. For example, product leadership may require research/development and engineering investment priorities, customer intimacy may require investment in CRM systems and techniques, and operational excellence may require that investments ensure superior price/performance quality at various price points.

Yet, defining and investing in a dominant value discipline does not mean that companies can neglect other disciplines. Once a priority is established, companies must ensure that they also remain competitive in other areas. Market leadership can also be derived from companies that efficiently integrate interdependent processes across these value disciplines. Even when not recognized as a leader in one of these specific disciplines, a company can create a source of customer value through effective systems integration.

Efficient processes balanced across product differentiation, customer intimacy and operational excellence also build value by satisfying unique customer requirements, such as custom development, build-to-order opportunities or just-in-time manufacturing markets. Emphasis on external efficiency becomes of utmost priority with the growing trend to outsource many business processes and operations.

In an era of information-driven business opportunities and increased demand for business flexibility, IT alignment with the business has a new meaning and new level of importance: the ability to support and at times drive sudden direction changes to capitalize on changing market opportunities. According to Rosser and Potter (2001), the alignment of IT and business strategy is the No. 1 concern of chief executive officers (CEOs) today. CEOs of fast-growth companies frequently indicate that IT is crucial for their success. The implication is that companies are working at a competitive disadvantage when their IT organizations are not aligned with business strategy.

To align with business strategy, the IT organization must be able to sense and respond, essentially becoming a fast collaborator with the CEO and business unit leaders. Critical to achieving this alignment is focusing on the impact of exemplary relationship management (Datz, 2003). This customer-centric focus causes IT organizations to move from supporting the business to becoming a business within a business, where the IT organization effectively competes and cooperates with outsourcers. In this model, outsourcing is a strategic decision, made in conjunction with the IT organization during the strategic planning process. There should be a direct relationship between business strategy and management of the IT portfolio of projects in place to implement that strategy. However, the seamless correlation between strategy and the project portfolio to ensure that the projects that will have the biggest impact on the desired strategic change are being undertaken in an orderly manner and with appropriate priority remains an inexact science in most organizations today (Archer & Ghasemzadeh, 1999; Dietrich, Poskela, & Artto, 2003; Dye & Pennypacker, 1999; Kaplan & Norton, 2001).

A review of the strategy and alignment literature reveals that most strategists have focused their efforts on various forms of strategic planning, strategic analysis and strategy formulation elements. The area of strategy implementation, which deals with operationalizing strategic plans, has been largely neglected (Roberts & Gardiner, 1998). The process for operationalizing strategic plans is still largely unexplored territory. It is difficult to envision how successful strategic plans can be devised in the absence of knowledge about how they are to be implemented. A comparison of the definitions of strategic planning and project management provides an indication that the two disciplines are compatible and, often, inseparable. A typical definition of strategic planning is, “a set of decision rules which guide the organization’s resource allocation process, taking into account both the short and long term, with emphasis on allocating resources in uncertain conditions to achieve future objectives. The organization which uses a form of strategic planning does not simply react to events in the present, but considers what should be done in order to achieve future objectives” (Scott, 1997. p. 11).

Hartman (2000) approaches strategy from the project manager’s perspective, suggesting that the best project and portfolio managers know how their projects support the corporate strategy and that they use this knowledge to help them obtain needed support and resources to succeed. The condition of knowing about the organization’s strategy is imbued through a process of legitimate peripheral participation within the organization's historical and cultural mechanism for creating strategy (Lave & Wenger, 1991). There is little doubt that ITPM can be an effective tool for the implementation of strategic plans (Roberts & Gardiner, 1998), but the variability of current practice makes it clear that better and more explicit methodologies are needed to ensure that IT projects and investments are well aligned with the strategy and direction of the business.

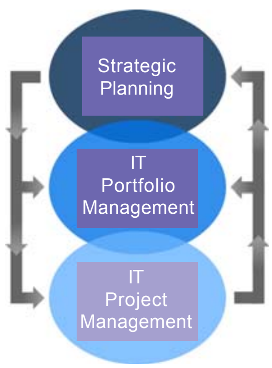
Aligning IT Investments with Corporate Strategy

The heart of the IT strategic planning process is arriving at a series of objectives or initiatives that provide guidance for selecting, maintaining and discontinuing IT projects (Luftman, 1996). IT project management strives to ensure that projects deliver results on time and budget. IT project management alone does not ensure that an organization is spending its resources in the right areas and doing the right projects. ITPM strives to ensure that the organization is doing the right projects and has enough of the right resources properly allocated to projects.

Selecting the right projects is only one element of organizational success. As Figure 1 suggests, strategic planning, ITPM, and IT project management must be synchronized, with strong, bi-lateral communications. Through the strategic planning process, the organization and individual business units determine their direction and identify key goals and objectives (Weill & Broadbent, 1997). This process provides the foundation for the selection of projects and assignment of resources (portfolio management). After the portfolio of projects is selected, the organization needs to apply its knowledge, skills, tools and techniques to create the products or services through the practice of sound project management. The strategic alignment of corporate strategy and IT investments is not possible without this interconnected approach to strategic planning, portfolio management and project management (Heldey, 1997).

Companies strive to balance the opposing objectives of fiscal restraint and investment risk. This is not a new challenge, as companies have always struggled with this issue.

Figure 1. The strategic alignment cycle



This challenge has been exacerbated in recent years by various management and economic shortfalls that have constrained the availability of capital, limited investments and tightened budgets in many organizations more than usual. To effectively manage these competing objectives, companies must adopt strategic planning practices that identify and exploit strengths while fostering greater alignment with the business objectives of the organization's internal and external stakeholders (Santhanam & Kyparisis, 1995). Many organizations fail to build on their success and stray from targeted strategic objectives or fail to foster and build consensus among their stakeholder groups.

The resulting implications serve to create undesirable effects on customer satisfaction, financial performance and market share. Therefore, all stakeholder groups should start from common ground and create strategic plans based on general agreement as to what the relative strengths of an organization are and how to consistently manage an investment strategy to further enhance and exploit growth. This does not mean homogenizing the business objectives of the stakeholder groups to eliminate competition among these groups. Competition fuels innovation, but it also often creates redundancy that increases overall costs. This redundancy often fails to trigger the potential economies of scale of earlier IT investments; hence, the opposing objectives.

Therefore, it is critical to structure strategic planning processes such that the source of corporate value is specified. This is accomplished by identifying, prioritizing and exploiting strategic investments according to customer intimacy, product differentiation or operational excellence that create a leading position within an industry (Jiang & Klein, 1999). No single organization can command a leadership position across all three of these areas. It is also imperative that management select and control investments using project portfolio management practices. This must take place to enhance and exploit an organization's source of value. Portfolio management provides the practices and principles needed to evaluate the relevant risks and rewards of various investment alternatives as they relate to stated strategic objectives, thereby facilitating conflict resolution across stakeholder groups (Solomon, 2002).

These principles and practices act as building blocks for strategic planning processes and are used to guide relevant IT investment decisions. This approach helps build consensus throughout an organization (among both its internal and external stakeholders) by clarifying and ranking investments relative to one another by distinguishing their value to operate, expand or transform the business. When these principles are practiced consistently, their use aligns business objectives and priorities across disparate groups, minimizes redundant efforts and reduces competition among limited investment resources.

Creating a Technology Evaluation Framework

With the rapid rate of technological change, a strategic process for evaluating new technologies is needed in all organizations today. Modern organizations need the ability to transform, grow and move in new directions. They also need the mental ability to embrace transformation. Every investment and project has to be viewed in terms of the level of maturity of the organization. IT organizations must align IT actions (e.g., outsourcing, process improvements, re-engineering, technology migration, etc.) with business mandates (e.g., reduce costs, reduce waste, increase efficiency, become more customer focused, etc.) and turn strategies into results (Luftman, 1996). IT organizations should be on the forefront of determining and tracking long-term measures that provide a balanced view of the company. This transformation will require a focus on planning, organizational structures and performance. IT leadership must balance market and technology vision with market and technology reality and core organizational competencies.

To effectively identify, evaluate and integrate new technologies, the organization must first decide how much to invest in research and development (R&D). The issue of how much to spend in R&D has become elusive as organizations focus on cost cutting, workforce issues and maintaining current assets (Weill & Broadbent, 1998). The organization needs to utilize IT to innovate in order to produce value for its customers. Although technology itself is a driver for innovation and growth, successful transitions are driven by successful communication. Innovation and costs must be managed through the transition. Once the IT organization is transformed into a business within a business, its people start to feed innovation and provide options for moving the organization forward (Rosser & Potter, 2001).

Organizations that have successful frameworks in place for identifying, evaluating and implementing new technologies maintain a value creation culture where everyone in the organization knows who the customer is and what the value focus of the organization is to the customer (Weiser, 1994). These organizations also recognize that good decision-making requires alternatives—they do not simply take the first option that comes along and run with it; they want their employees to think out of the box. Change is viewed as positive and productive, and uncertainty is embraced (Spradlin & Kutoloski, 1999). Successful technology evaluation frameworks require an outside-in strategic perspective that examines factors outside of the organization and how they affect the business.

This perspective requires systems thinking that views the organization holistically, encourages open-information flows to all levels of the organization, and fosters the empowerment of management at all levels. Strategic decision-making that utilizes disciplined portfolio management processes and principles is at the core of successful strategic framework implementations (Kerzner, 2001). The principles that enable the organization to be innovative are not necessarily things that the organization does; they are ways of approaching and thinking about business investments and projects.

Building the IT Portfolio Plan

Projects undertaken by the organization should be a reflection of the organization's business strategy and able to be directly linked to the components of the business strategy that they support (Cooper, Edgett, & Kleinschmidt, 1997a). IT is often highly complex and difficult for non-specialists to understand. It is crucial for business executives to understand enough about IT to make significant and far-reaching strategic decisions. ITPM forges a critical link between the strategic planning process and the project management process, enabling management to reach consensus on the best use of resources by focusing on projects strategically aligned with the goals of the business.

An IT portfolio is more than a set of projects. It is comprised of a set of managed technology assets, process investments, human capital assets and project investments allocated to business strategies according to an optimal mix based on assumptions about future performance (Solomon, 2002). One of the goals of ITPM is to maximize value and risk tradeoffs in optimizing the organization's ROI. ITPM is an optimal way to categorize, capture and communicate IT value in business language. Value is achieved from the right balance of risk-and-reward decisions. Through this process, potential risks are identified and the likelihood of occurrence and severity of consequences are determined (Visitacion, 2003).

Identifying scenarios and evaluating risks leads to high-value IT portfolios. ITPM is the continuous process of selecting and managing the optimum set of project-oriented initiatives to deliver maximum value to the organization. Historically, ITPM has consisted of an intensive point-in-time review, with the goals of determining the current state of affairs and of making recommendations for changes in the project portfolio. These endeavors are highly labor intensive, and the results are extremely time-sensitive. While valuable in terms of the information it offers, this process typically produces static reports with relatively short shelf lives (Gliedman, 2002). A better process for ITPM is a continuous process of selecting and managing the optimum set of project-oriented investments that deliver maximum business value. Continuous ITPM begins with the development of a plan outlining how broad and deep the portfolio should be (objectives), what measurable expectations exist, and the risk and reward boundaries. Precursors to these activities include determining the IT organization's readiness to develop and benefit from ITPM, determining the IT organization's capabilities to successfully implement ITPM (including several capability assessments) and the development of an overall organizational charter for ITPM (Miller, 1997).

Over time, the project portfolio may deviate from the stated organizational objectives, resulting in disproportionate levels of spending among projects that may not fully align with current strategic objectives. As a result, the actual strategic investment may vary significantly from the intended strategy. Strategic alignment analysis will uncover opportunities to improve the overall portfolio strategic alignment through modifications to the project portfolio. The portfolio plan is developed to define the portfolio investment strategy and structure. This plan includes categories into which investments will be split, the target investment mix across those categories and goals (risk/reward tradeoffs) for the portfolio (Buss, 1999). Triggers that will cause the portfolio to be re-evaluated and potentially rebalanced are also determined.

Underlying ITPM is the fundamental belief that IT property (e.g., hardware, software, data) and expenditures should not necessarily be considered costs or expenses—instead, they should be viewed as assets and investments that have unique value to yield measurable returns over time and managed as such (Broadbent & Weill, 1997). In addition, ITPM is both an analytical technique used to evaluate investments and a managerial tool used to prioritize and allocate IT resources. An IT portfolio must be prioritized for its ability to (1) consider assets and investments for their efficiencies to support day-to-day operations, (2) consider assets and investments that support the expansion of the business by improving asset use or migrating to more effective/efficient processes, and (3) consider assets and investments that seek new business opportunities.

Once the investments are listed, the organization can finalize the initial scope and depth of the portfolio management implementation. For some organizations, simply categorizing IT investments and using the portfolio as a communication tool is enough, whereas other organizations elect to apply the detailed statistical and management process disciplines of portfolio management to their business and IT investments (Rosser, 2001). Scale often drives the scope of ITPM implementations: Smaller IT groups can follow a simple portfolio management implementation; larger IT groups will benefit from the rigor and discipline of a detailed process. In either case, using a formal implementation process will accelerate business recognition of IT value and provide the most effective basis for ensuring the appropriate IT organizational structure.

According to Bonham (2005), the most basic use of ITPM is for communication of the elements of the IT portfolio in a business framework. Organizations starting ITPM often position the process as a communications tool. This perspective will focus the organization on the initial scope and business dialogue needed to create a single repository of categorized IT investments. This inventory will include IT assets and projects categorized for business-appropriate dialogue. Project prioritization, business case justification, basic IT governance and relationship management processes start to take shape as a result of the communication fostered by ITPM.

As portfolio management matures within the organization, individual ITPM within the IT group emerges. This level of ITPM allows for the active management of a portfolio—proactively balancing risk and reward. The initial target is usually a thematic (e.g., enterprise resource planning/ERP, CRM) sub-portfolio of IT assets and projects. Larger-scale IT groups will find it beneficial to appoint an overall portfolio manager to ensure coordination across portfolios. These groups typically combine relationship management (including change and problem management), services and products creation and delivery, and planning and measurement responsibilities.

After the organization develops a comfort level and competencies utilizing ITPM with a sub-portfolio of IT assets and projects, it typically advances ITPM across the entire IT organization (Bonham, 2005). This level of ITPM seeks to integrate all of the IT organization's assets, projects, resources and processes into one IT organization-wide investment portfolio. The process integration knowledge gained by assessing the deployment of ITPM at an individual sub-portfolio level is used to prepare the portfolio management plan covering the entire IT organization. IT organizational processes must be mature and integrated for this level of ITPM to be successful.

Once ITPM is engrained within the IT organization, portfolio management across the entire enterprise is typically the next evolutionary stage in portfolio management maturity. At this level of ITPM, the processes of the IT organization are no longer separate from business processes (Luftman, 1996). IT planning is fully integrated into business planning. Business planning cycles are dynamic, in contrast to the usual static yearly cycles. At this level of ITPM, the focus is on creating highly collaborative, high-performing, enterprise-wide operations that optimize the organization's portfolio of assets, projects, processes and resources. Business and IT organizational structures are merged into one organizational structure that has integrated portfolio management into its planning and management processes (Rosser & Potter, 2001).

Creating the IT Portfolio

The first step in implementing portfolio management is to appropriately categorize the organization's IT investments. A portfolio is a categorized set of assets and investments. The items in a portfolio are typically classified by the level of risk vs. expected benefits, the current fair value of the investment and the expected investment life cycle. The IT portfolio will consist of activities/processes, projects and assets (e.g., liquid vs. illiquid, expense vs. capital, hard vs. soft, goodwill). The asset and project portfolios should be closely linked (e.g., a major improvement to an asset is a project) (Cooper, Edgett, & Kleinschmidt, 1997b).

Many organizations employ a three-category model for asset and project categorization: operate the business, expand the business and transform the business (Heldey, 1997). Organizations should adapt these categories to their particular context—taking into account their risk tolerance and process maturity. Gray areas between each category will exist and need to be managed within the linked value management, portfolio management, project prioritization and business case justification processes. Operate-the-business investments are needed to keep the business functioning. Spending in this category provides mission and business-critical services. Common spending entities in this category include electricity, lighting, heating/air conditioning, telephone dial tone, network services, IT vendor support and disaster recovery. Typical external influences that modify spending decisions in this category include business climate changes and corporate events or activities (e.g., mergers, acquisitions, divestitures) (Bonham, 2005).

Expand-the-business investments are needed to grow the organization's scope of products and services. Investments in this category might include software upgrades, adding incremental capacity or developing skills within the staff through additional training and other efforts. Spending in this category affords new levels of process efficiency and effectiveness that the business perceives it will need in the future and which the current assets cannot deliver. Assets in this category influence business performance through process agility (effectiveness), or through the ability to respond to new service requests in significantly less time than predecessors were able to respond. Transform-the-business investments involve project-based spending that creates new IT services that broaden an enterprise's ability to enter new markets. Emphasis in this category is on the speed required to gain control of a new market via first-mover advantage (Luehrman, 1998). Sample investments include new business ventures, mergers and acquisitions, new products, major new business initiatives and business process outsourcing.

Categorizing IT investments implies first listing the investments and grouping them by business unit and by overall shared services/products. Implementing portfolio management in such an environment can be considered business unit by business unit, with the shared-services IT portfolio considered one business unit. Given the typical scale and scope of CRM and ERP projects, significant value to the business is returned by applying portfolio management to the IT investments at the business unit level. As the organization-s portfolio management experience matures, grouping business unit portfolios together and managing them holistically is the natural evolution of applying the discipline of ITPM (Miller, 1997).

During the categorization process, information that the organization needs to make portfolio categorization decisions is compiled. This information takes many forms and comes from a variety of sources. Often, there exists a list of currently active projects and another "wish list" of requested or proposed projects awaiting further review. Some of these projects will have detailed work plans and many of the larger projects will have extensive scope and business case documentation that can be leveraged. Also, interviews and discussions with stakeholders will uncover information on otherwise "unknown projects" to complete the portfolio categorization process (Grochow, 1996).

Rather than focusing on detailed task assignments and project schedules, the data collected should be high-level. The data collection focus should be on capturing information that will be used in the categorization process. The information gathered is both quantitative and qualitative and generally contains information about projects, schedule and cost estimates, budgets, strategic initiatives, dependencies, expected benefits, risks, relative priority, value and ranking (Meredith & Samuel, 1995). Information about available roles, resources, costs, skills and other important organizational information is also captured during the categorization process. Investment value is achieved from the right balance of risk and reward. Identifying potential risks, determining their likelihood of occurrence and determining the severity of consequences are essential parts of the portfolio creation process (Smith, 1996).

The appropriate mix of investment categories must be a dynamic business decision driven by market requirements, competition, internal requirements, business strategies and so forth. The belief that a proper mix exists is a dangerous assumption or strategy. The operate-expand-transform mix is neither a destination nor a primary performance indicator. Setting a good portfolio mix and managing toward it creates momentum and a performance culture that manages velocity metrics rather than a static portfolio mix. IT organizations that view management of the IT portfolio in this fashion are most apt to maximize their value to the business (Bonham, 2005).

According to Rosser (2001), typical IT portfolio mix ranges are 50%-80% operate the business, 10%-35% expand the business, and 0%-25% transform the business. When a high-performing organization makes a significant capital investment, its mix will typically shift significantly to the operate-the-business category. However, just because it is now spending more in this category, it does not cease being a high-performing organization. The operate/expand/transform mix is not an indicator of performance capability. The mix is only an indicator of current financial flexibility. For example, current spending on transformation is not what indicates transformation capabilities. That emphasis may be a last-minute, frantic attempt to avoid a catastrophe.

Technology's breadth, depth and upgrade cycles are making it difficult for IT organizations to cover the entire, ever-expanding IT list of organizational needs (Shoval & Giladi, 1996). The ITPM approach allows management to identify which elements of the core IT competencies—planning, marketing, integrating, maintaining and human capital management—should be housed internally and which should be selectively outsourced. This process also assists in deciding which elements of which competencies are non-discretionary and which are discretionary. Building competencies should follow the strategic plan, which also implies a short-, medium-, and long-term planning horizon that must be considered (Visitacion, 2003). During this process, planners must evaluate their existing portfolio of assets to determine whether they can be further exploited for strategic advantage or whether additional investments are needed. This is where the delicate balance between fiscal control and strategic investment creates the greatest source of internal debate.

The assets of a typical IT portfolio consist of applications (e.g., ERP & CRM), data and information (e.g., customers, products, financials), services assets (e.g., consulting, engineering, security), infrastructure (e.g., servers, storage, networks), operations (e.g., data centers, help desks) and human capital. Assets are typically segmented into core, non-discretionary, discretionary, strategic and venture categories (Visitacion, 2003). Core assets are necessary expenses to enable operation of the IT organization (e.g., power, facilities, maintenance). Non-discretionary assets are typically forced expenditures caused by regulatory compliance, expansion or the need to replace outmoded or worn-out assets. Spending activity in this category centers on expanding existing capacity to meet growth requirements rather than to introduce new services.

Discretionary assets are required expenses to upgrade or replace existing assets (e.g., platforms, application versions). Spending in this category affords new levels of process efficiency and effectiveness that the business perceives it will need in the future and which current assets cannot deliver. Strategic assets are typically designed to support a growth or transformation business strategy (e.g., CRM, product life-cycle management, supplier relationship management) (Luftman, 1996). This category includes project-based spending that creates new IT services to deepen an enterprise's existing market penetration (e.g., expand market share). Venture assets are typically used to incubate future business opportunities or experiment with the transformation of business models or product/service lines (Gliedman, 2002). This category includes project-based spending that creates new IT services to broaden an enterprise's reach to enter new, untapped markets.

Managing the IT Portfolio

After the portfolio categories are established, each investment is placed in the appropriate category based on the risk-and reward decisions made in the IT portfolio plan. A strong portfolio measurement process is valuable for assessing actual IT portfolio performance against targets set in the planning phase and outlining discrepancies.

Monitoring triggers should be established that signal potential portfolio problems. Following a formal portfolio management process will allow the organization to optimize the return on the overall IT investment portfolio and maximize its use in creating business innovation.

The key disciplines of planning and strategy, future-state planning and project management all overlap at the central core of the IT portfolio (Ghasemzadeh, Archer, & Iyogun, 1999). The planning and strategy discipline enables innovation and manages the business related to the particular asset portfolio, while future-state planning designs the evolution of the portfolio. The portfolio management process consists of two interrelated cycles: asset portfolio management and project portfolio management, both driven by business and IT strategies. These, in turn, frame the enterprise prioritization process for the identification, creation, acquisition or deployment of the assets (Bonham, 2005).

The asset cycle continually seeks to optimize the value that the assets are able to generate by identifying improvement, optimization, creation/acquisition and innovation opportunities. Optimal timing for asset disposal/retirement is understood and planned for upfront at asset creation or acquisition. Any projects necessary for asset creation/acquisition/improvement are identified and passed to the project portfolio management cycle. Asset usage is monitored to ensure optimal return, and value generated is assessed regularly to drive the appropriate use/retirement/enhancement strategy (McFarlan, 1981). The typical asset portfolio will include applications (ERP, CRM, e-mail, etc.), data and information, services, hardware, processes and human capital.

The project cycle actualizes the prioritized business transformation opportunities identified in business/IT planning and asset improvement identification. New projects are added either as recently identified and prioritized opportunities or as previously developed scenarios whose triggering event has occurred. Project adjustments (accelerate, slow down, retire) may also occur based on regular reviews of the projected value that the project will generate (Visitacion, 2003). Organizations should re-evaluate the business cases for both ongoing and non-triggered projects and take appropriate action to optimize the portfolio's value. This re-evaluation should occur on a regular basis, preferably quarterly. As projects enter the portfolio, their implementation is overseen and managed. Delivered projects' value is measured and assessed against initial expectations. Modified/created assets are transferred to the asset portfolio and managed as previously described.

According to Spradlin and Kutoloski (1999), portfolios should be managed with a life-cycle mindset, including stages such as portfolio goal setting, portfolio performance measurement and closing the cycle by adjusting and rebalancing the portfolio appropriately (adding, accelerating, decelerating and exiting portfolio components). The asset and project portfolios and their management processes should be embedded into the business and IT ecosystems. Building robust portfolio management capabilities is a staged process, tied to business and IT process maturity.

Performance improvement options (e.g., shifting resources from one project to another, developing new skills, providing user training) are developed by the governance body that oversees the portfolio management process (Miller, 1997). The project portfolio is continually reviewed with respect to strategic direction and external factors. This process involves defining and monitoring status metrics to keep projects on track and ensuring that executives and stakeholders are engaged. Adjustments to the project portfolio are made as strategic and operational plans change. Continuous monitoring of the project portfolio leads to frequent fine-tuning and occasional major shifts in the portfolio.

Project costs are summarized across multiple investment categories and compared with industry benchmarks to create baselines, set targets and balance the project portfolio. Most importantly, project value is captured and summarized to evaluate and maximize the value of the entire project portfolio (Rosser, 2001). An inventory of all projects is conducted to properly assess resource demands and ensure that the organization has enough resources to make the project portfolio achievable. The projects are mapped to the business strategies for a better view of the portfolio's strategic alignment.

Maximizing value, finding balance and aligning with corporate strategy while ensuring achievability in the project portfolio is challenging. Focusing on any one of these four goals in the absence of the others will lead to very different results. For example, fully maximizing the value of the project portfolio may lead to a poorly balanced portfolio that is neither aligned with the organization nor feasible. Therefore, optimization should be approached as an interactive review process to optimize the project portfolio in the face of multiple (and possibly conflicting) goals (Luehrman, 1998).

This process begins with a review of the findings uncovered during the portfolio analysis. Strategic alignment issues may have been identified, or over-allocated (or mis-allocated) resources may indicate that the project portfolio is not realistic or feasible. Clear objectives should be defined that target desired organizational outcomes before any changes are made to the project portfolio. A cost and resource impact analysis will assist in uncovering portfolio adjustments needed before an achievable project portfolio is achieved. The process continues by reviewing portfolio strategic alignment and balance. Trade-offs are considered through multiple iterations of this process and final portfolio adjustments are made to arrive at the optimal project portfolio (Bonham, 2005).

The result of an iterative review process is an optimized project portfolio based on specific goals and constraints. Testing the impact of multiple what-if conditions on the project portfolio is an important element in the ongoing optimization process. The main benefit of what-if analysis is the potential to discover creative solutions by modeling the project portfolio under a variety of different conditions (Spradlin & Kutoloski, 1999). For example, this what-if analysis allows management to test the schedule and cost impacts of slowing a project, accelerating a project or canceling a project.

The main goal of scenario planning is to model a range of possible external impacts on the project. This form of modeling is in many ways a structured what-if analysis for selecting from multiple options. In scenario planning, each scenario is defined as a collection of what-if conditions and their outcomes. For portfolio optimization, scenario planning allows planners to choose from several equally valid project portfolios by determining which of the portfolios is best equipped to handle the range of possible external factors.

The ITPM process is designed to create the optimal IT project portfolio within the environmental, political and technological constraints of the organization. In most cases, this means that the final portfolio will be sub-optimal in some respects, but it will be the best project portfolio that the organization can implement at that particular point in time.

Optimizing the project portfolio requires a collaborative approach to reviewing and adjusting the portfolio. Reaching consensus in this process can be challenging due to the number of variables involved. Real-time what-if analysis in a group setting is usually not very efficient. However, the scenario planning process can help focus the discussion on the merits of the alternatives (Ross & Beath, 2002). This process requires that the decision makers define the scenarios and associated constraints. Next, the project portfolio analysts construct multiple alternative portfolios off-line, ensuring that each alternative is achievable given the current constraints. After the merits of each alternative portfolio are discussed, a consensus decision or direction for refining the alternatives is typically achieved.

Managing Projects and Assets within the IT Portfolio

Project management is a proven technique to manage key attributes about a project, including scope, time, cost, quality, communication, risk, human capital, procurement and integration (The Standish Group, 2003). These attributes are tracked throughout the design, engineering, development and deployment phases of a project. Activity timelines, resource schedules and funding commitments are common mechanisms to track in this process (e.g., budget vs. actual expense). This enables managers to respond to the unplanned impact that these constraints have on project goals. The orientation of project management is typically inwardly focused and not sensitive to external influence.

Portfolio management is a structured technique to categorize, evaluate, prioritize, purchase and manage an organization's projects and assets (e.g., hardware, software, human capital, processes) (Pastore, 2003). It is based on current and future economic drivers, as well as on the acceptable value/risk balance desired by the business. Portfolio management enables a responsiveness to market dynamism not provided by project management. This includes dynamic modeling and the updating of prioritization for project and service enhancements, as well as the updating of funding decisions driven by constraints imposed by the business.

Project portfolio management is a macro-level control mechanism to ensure that enterprise strategies are operationalized (Bonham, 2005). Strategic change occurs through change projects. However, for the macro-level portfolio to be effective, the micro level (i.e., successful project executions) must be refined. Micro-level change control occurs through project management. Effective project management enables better control over the allocation of scarce resources, manages change more effectively, improves the image of IT by delivering on expectations, improves customer satisfaction through effective change control and expectation management, and attempts to contend with emerging challenges. Project management provides consistent processes, appropriate metrics and needed control. Project management is the most critical enabler of a successful project portfolio (Solomon, 2002). In the absence of project management, the project portfolio is merely a collection of unbridled initiatives supporting common objectives.

Enterprise project management capabilities provide for the proper rollup of project information into the IT project portfolio. When projects are completed, consistent project management methods should enable the state change from IT projects to IT assets, promoting better IT asset portfolio management. Project costs, projected benefits and expected asset life cycle can be consistently transferred into the asset portfolio via consistent project management methods, enabling more effective asset portfolio management. Project tracking information incorporated in this manner often translates into hard-dollar productivity gains (Grochow, 1996).

Assessing IT Portfolio Execution

Most organizations utilize financial models to determine the value of their projects. Many of these models use financial metrics that consider the value of money invested over time and the cost of the company's capital, such as net present value (NPV) and the internal rate of return (IRR), to evaluate the cost of implementing projects, along with a stream of future projected revenues or other benefits (Visitacion, 2003). The projected financial benefits may take a variety of forms, such as expected revenue growth and/or operating cost reductions. Though financial modeling is an important component of determining project value, it is not the only aspect of value that should be considered. Non-financial benefits (improved customer satisfaction, reduced defects, increased market share, etc.) can be quantified and evaluated using non-financial metrics. Scoring models are an effective metric that use non-financial ratings to produce a form of value measurement that can account for a variety of financial and non-financial benefits (Buss, 1999). As companies become more sophisticated in their processes to measure value, they often evolve mixed value measurement processes and tools that combine traditional financial metrics with non-financial scoring metrics to prioritize projects.

According to Combe and Githens (1999), there are two major challenges in determining the value of a project. The first is to define a methodology that allows for comparison of the value of one project to another. Most projects have a number of intangible benefits that make comparing one project to another difficult. In addition, large projects often have larger costs, so the net of the project benefits minus the project costs is important for accurate project comparison. The second major difficulty in determining project value is to account for the time value of costs and benefits. In general, project costs are incurred before project benefits are realized, and the value of the project benefits received today is worth more than it will be in the future.

Both of these issues are addressed in traditional financial models by converting costs and benefits into offsetting streams of discounted cash flows. NPV and IRR are the most commonly used financial models; however, a number of variants exist. NPV is widely considered the best absolute measure of value (Gardiner & Stewart, 2000). This financial model factors the opportunity cost of capital (or discount rate) into the equation for calculating economic value. IRR is not an absolute value, but rather a ratio (or rate). This ratio is useful for comparing dissimilar investments. IRR is also useful for making comparisons between different-sized projects, different periods and for making international value comparisons. The expected commercial value method is used to determine the commercial worth of each project to the business (Grochow, 1996). The expected commercial value calculation is based on a decision-tree methodology that considers the probabilities of both technical and commercial success, the strategic importance of the project, and the future stream of costs and benefits. Economic value-added is a value-based measurement technique that calculates after-tax cash flow generated by a project minus the cost of the capital required to generate the cash flow. Economic value-added is used to represent real profit vs. paper profit and report shareholder value, a major area of focus for many corporate strategies today (Buss, 1999).

In many cases, the benefits from each project do not start accumulating until the project has been completed, and then the benefits often extend months or maybe years beyond the end of the project. Therefore, to accurately measure a project's ROI, it is important to keep the project in the portfolio well past the completion date. After the actual costs and benefits for each project are captured, the same financial models used to estimate value (e.g., NPV, IRR) can be used to calculate a project ROI over a given period of time. The capturing of actual costs and benefits at a project level allows for the calculation of the ROI for the entire project portfolio (Gliedman, 2002). This provides an objective measure of the value that the project portfolio is producing and also helps executives understand how to align the projects in the portfolio.

Financial models typically utilize only a few key criteria for calculating value. Scoring models, on the other hand, may use many more criteria in assessing a project's value. Scoring models have the added benefit of using subjective measures to calculate project value. These models can be more complex to implement, since they often rely on decision makers to provide much of the data in the form of ratings assigned through a review process. With scoring models, projects are typically rated on a number of questions or criteria that constitute superior projects. These ratings are weighted and totaled to produce a single score. This score is used as a proxy for the value of the project to the organization. This value proxy incorporates strategic alignment and balance considerations beyond pure financial measures (Jiang & Klein, 1999). The Productivity Index is a financial scoring model that utilizes expected commercial value, technical risk and remaining R&D expenditures to derive a financial value index that can be used for ranking projects in the portfolio. The Dynamic Rank Ordered List is another scoring model that utilizes a ranking technique that combines financial and subjective ratings and ranks projects accordingly (Gliedman, 2002).

The need to accurately define the portfolio's value has led to the creation of activity models for project and asset costing. A shift from industrial activity with 80% fixed and 20% variable costs to information management with 20% fixed and 80% variable costs has created IT management uncertainties (e.g., competitor innovation, staffing shortages and changing customer demands) (Rosser, 2001). Innovation, management capability, employee and customer relationships, quality and brand value explain a significant proportion of a company's value, and IT managers must learn to model these intangibles to effectively contribute to business value. Activity Based Costing (ABC) is the instrument that many leading organizations are using to fully allocate, value and communicate IT services, products and costs.

ABC is an alternative to traditional accounting methods and allows an organization to identify activity centers and assign costs to products and services based on the number of events or transactions involved in the process of providing a product or service. One of the goals of ABC is to determine the actual cost associated with each product and service produced by the organization without regard to the organizational structure. With costing based on activities, the cost of performing each activity in a project can be ascertained and evaluated. The premise behind ABC is that controlled change cannot be initiated in a company that does not measure its processes and activities (Rosser, 2001). Strong leadership cannot compensate for poorly understood processes. Organizational agility and learning require investing in processes, products and services that offer sustainable advantages, and ABC captures the information needed by management to make effective decisions. By supplementing accounting measures with non-financial data about strategic performance and activity details of strategic plans, companies can communicate objectives and provide incentives for managers to address long-term strategy.

Assessing New Technologies

Organizations view technology in two ways: continuous and discontinuous. Continuous technologies are built on what already exists in the organization. Discontinuous technologies come from R&D activities and offer radically new approaches to problems. Trend linkage is a critical piece for forecasting new technologies and their impact on an organization. The balance between people and technology is an important consideration in this process. There is a delicate balance between what organizations and individuals do and the way in which new technologies are introduced and used. Forecasting requires making decisions within a framework of uncertainty, and uncertainty implies risk. Navigating new technologies from a risk to an opportunity requires a good understanding of the primary value that the technology creates for the organization. The alignment of the organization's IT strategy with its business strategy is crucial for managing the risks and realizing the value associated with new technologies.

Managing the IT portfolio entails examining how much risk an organization can afford and applying the appropriate IT financial investment strategy. Many organizations today are using a real-options approach to the financial analysis of new technologies. A real-options approach depends on the business impact of the initiatives themselves and the forecasted impact of the initiatives. It accounts for future opportunities and the uncertainty involved with new technologies, which traditional project measures like NPV do not (Luehrman, 1998).

Traditional financial planning tools and techniques (DCF, NPV, ROI, IRR, etc.) are incomplete and do not give a sufficient view of risk and reward in today's volatile, fast-moving world (Copeland, 2001). Many organizations are evolving the current, mostly financial process to a risk/reward-balanced scorecard approach. This approach is enhanced with options and portfolio management best practices borrowed from the financial industry used for valuing and managing the organization's IT investments.

Real options analysis (ROA) treats strategies as chains of related business options that should be separated and quantified. According to Luehrman (1998), the process consists of four steps:

1. **Uncovering real options:** Real options are usually buried inside complex webs of interdependent investments. To expose option opportunities, scenario analysis is frequently used to identify variables that could significantly alter outcomes. Cash-flow patterns are also examined for investment peaks that may signal opportunities to change paths.
2. **Gathering the data necessary to value real options:** Accurate quantification of real options requires data on several variables:
   - The cost/benefit ratio of the option
   - The exercise price
   - The value of the underlying asset
   - Time to expiration
   - The risk-free rate of return
   - The uncertainty (e.g., standard deviation) of projected returns.
3. **Calculating the value of the option:** This step employs tools common to financial option analysis to quantify a real option's dollar value.
4. **Using the analysis to create beneficial strategies:** Add the value of real options to the value of the same project as calculated by traditional analyses. Develop dynamic strategies that convince the organization to change behaviors.

ROA enables the chief information officer (CIO), often working in conjunction with the chief financial officer (CFO), to provide improved business strategy advice to the business units. It combines static financial calculations with a time-phased view of the value of implementing the projects in portfolio at different times in the future. A major challenge in this process is to provide a realistic assessment of the risk associated with each option. The benefits of ROA are agility, a sense-and-respond ability to adapt the business value of the project portfolio to changing conditions as they happen, the ability to consider deferring the decision to continue and the ability to quantify the value of deferring as an input to the decision-making process.

ROA also enables a more accurate assessment of the value of long, large multi-phased projects, such as ERP and CRM. Many organizations are beginning to use this more accurate assessment to assist their business units in increasing the accuracy and quality of their decisions, thus further illustrating the value of their IT organizations to the enterprise. The primary value of ROA is that it enables CIOs and their business unit colleagues to dissect and reassess a business and/or technology strategy. It enables them to break large, complex problems into smaller, simpler ones. It also helps them identify risk components and decide which ones to hold, hedge or transfer.

Case Study: British Airways

In 1994, British Airways (BA) discovered that approximately one-third of its customers were dissatisfied with their flights. The company also discovered that less than 10% of *these dissatisfied customers made contact with the company's customer relations department. Internal research established that a delay in responding to complaints led to a 30%-45% decline in possible intent to reuse BA. However, the effect of this decline in possible reuse intent on actual future behavior was not clear.*

BA's CEO at the time, Colin Marshall, established a strategic focus of "putting the customer first"—which meant much more than just getting to the destination on time. As a result, BA invested approximately U.S. $9 million in a system that enabled customers to register complaints faster. The company did not know the financial benefits of this system in advance and a cost-benefit analysis would not have produced meaningful results during the decision-making process. However, the intangible aspects of the project (particularly the fit with corporate strategy and improved customer information) meant even if the project generated no additional income, it provided a foundation for further projects to win back an estimated U.S. $800 million in potentially lost revenue that the dissatisfied customers represented. This case is an instance where the strategic considerations of a project were far more important than the short-term emphasis on revenues and costs.

Communicating the IT Portfolio

It is critically important that all stakeholders understand the IT portfolio plan and any changes made. This involves developing communication plans, delivering the messages to stakeholders and measuring communication success. Communication is a particularly critical part of the initial adoption of ITPM in an organization (Pastore, 2003). As the portfolio management process evolves into a continuous cycle of analysis and fine-tuning, the portfolio changes become less significant and the adjustment process becomes more efficient through standard practice. When implementing large changes to the project portfolio, there is risk of pushing the organization into a long adjustment period of very low productivity as plans are adjusted. Clearly communicating the changes required to move to the newly optimized project portfolio, as well as the logic behind the decisions, is critical to minimizing any down time associated with the change in strategic direction.

According to Visitacion (2003), effective communication serves two objectives. First, it clearly outlines the changes and unambiguously defines the new direction. The new project portfolio represents a top-down plan that sets direction and constraints to guide the bottom-up planning activities. The new direction and constraints, along with any assumptions, must be clearly conveyed to make the detail planning as efficient as possible. Second, communication provides the rationale for project teams to make changes in support of the "bigger picture." Ensuring project teams understand their role and their contribution to the value, balance and alignment of the project portfolio is important for building buy-in and support. Buy-in is not a black-and-white issue, but rather a matter of degrees. The more buy-in and support obtained, the more efficiently the changes will be implemented and sustained.

IT Portfolio Governance

Bigelow (2003) argues that portfolio management is critical to project justification and governance. The role and importance of governance in organizations has increased steadily over the last 10 years, reflecting a rise in complexity and uncertainty in the internal and external environments that confront organizations (Williams, 2003). The principles and theories of governance concerning accountability, responsibility, direction and control are expressed by the Asian Development Bank (1998) as four fundamental pillars of governance:

- **Accountability:** The capacity to call officials to account for their actions.
- **Transparency:** Entails low-cost access to relevant and material information.
- **Predictability:** Results primarily from laws and regulations that are clear, known in advance, and uniformly and effectively enforced.
- **Participation:** Needed to obtain reliable information and to serve as a reality check and watchdog for stakeholders.

IT governance is about assigning decision rights and creating an accountability framework that encourages desirable behaviors in the use of information and technology. ITPM is a powerful tool for IT governance that requires close connections among principles, processes, people and performance (Datz, 2003). As IT services are increasingly embedded in business operations, the IT focus shifts from cost efficiency to operational effectiveness and business process enhancement. To develop a strategic role within the business, the IT organization needs to pass through several phases, from being an order taker to becoming an integrated business partner with the rest of the company's activities (Prahalad & Krishnan, 2002). To make this evolution, the IT organization must educate the business about the services it provides (in terms of costs, quality, time to market, value, and risks involved), while constantly managing and maintaining a balanced portfolio of assets and projects that support the business.

It is critical to stress that IT governance is enterprise-wide governance, meaning that it requires both the IT organization and the rest of the business to be active participants. Gaining business unit participation in IT governance is a critical success factor for establishing a project priority scheme (Bonham, 2005). Effective IT risk management entails both top-down and bottom-up risk-management practices. Top-down management addresses risk in a granular, synchronous fashion, supporting executive-level decisions around portfolio initiation, investment strategies, progress review and value strategies. The focus is on understanding risks before plans are defined or operationalized. Conversely, bottom-up management concentrates on performing detailed, continuous assessment of risk and deals with day-to-day operational risks. Together, they provide a 360-degree, multidimensional view of risks that considers an organization as a whole.

The heart of IT portfolio governance is the strong connection between principles, processes, people and performance. Processes and principles, the heart of organizational culture and governance, are fundamental to ITPM (Kirsch, 1997). IT portfolio governance must establish enterprise-wide governing principles to articulate governance guidelines within which expected behaviors occur within the enterprise. In many organizations, the IT portfolio manager role is initially fulfilled by the CIO and functional vice presidents or directors. A governing body should be created that includes senior IT and business unit leaders, which develops the principles for governing appropriate for the organization.

The principles component of IT portfolio governance has two primary functions: principle development and principle compliance. A consistent set of principles must articulate the guidelines within which expected behaviors occur with the intent of directing the enterprise toward an acceptable level of commonality (Miller, 1997). Examples of IT portfolio principles include the decision that IT investments are classified as either assets or projects, that investments will be divided into categories meaningful to the business and relevant to the IT organization (operate-expand-transform) and that the investment mix is to be defined by an IT portfolio steering committee, with balancing and tuning recommendations made by the IT organization.

A set of consistent, enterprise-wide processes must be defined to execute the governing principles. These processes can broadly be grouped into operational processes, administration processes, financial processes, logistics processes and strategic processes. Effective IT portfolio governance requires governing bodies to ensure that relevant principles and processes are developed, adhered to and evolved over time. These groups include the executive steering committee, IT steering committee, IT architecture team, enterprise program management office and various centers of excellence. The most overlooked and ill-managed aspects of IT portfolio governance are the controlling of performance (controls and checks) of the various IT governance processes and the monitoring of compliance with established principles (Meredith & Samuel, 1995).

Executive steering committees are special committees usually appointed by the CEO or board of directors of an organization to carry out specified tasks and submit findings and recommendations. IT steering committees are usually tasked with identifying projects and establishing IT plans and priorities. These committees are typically comprised of business unit and IT representatives. The IT architecture team makes technology policy, design and implementation recommendations and typically reports to the IT steering committee. Typical areas of responsibility include database, hardware, information, security, software and data center operations. The enterprise program management office oversees enterprise-level projects that are typically interrelated or interdependent to eliminate duplicate work and allow for staffing and decisions across the projects.

Centers of excellence (COEs) replace the traditional relationship between IT and business, where business advocates request IT services, define needs to IT representatives, and then test and implement new or revised systems. In a COE model, some traditional IT functions shift into the COE, including business process design, integration management, and enterprise application business functional configuration and programming. The essential function of the COE is to drive continual business benefit through optimization of business processes, optimization of end-user competency, and the continued coherence and integration of functionality and data through all processes.

The COE is typically run by the enterprise program management office, which typically reports to the CIO and IT steering committee. Although the IT COE may reside within the

IT organization, it is made up of elements from across the organization. COEs are typically organized by workgroups bound by common themes, policies, requirements, procedures, process owners and core IT functions. COE workers share goals, standards, performance measures, tasks and management. COEs help to ensure tight business and IT alignment.

Effective IT portfolio governance mitigates conflict between long- and short-term goals. An enterprise can neither be focused just on the tactical, day-to-day decisions to promote immediate revenue and profit, nor can it focus only on the strategic, future-oriented vision of the enterprise to promote long-term growth and persistence. To transform while performing, conflicts between these opposing forces must be mitigated. Good governance practices also create a climate of trust and increase agility and freedom of action. Individual trust, decision-making and empowerment must be fostered within the governance structure for effective portfolio governance.

IT portfolio governance should not become so formal and rigid that no decisions are ever reached. Effective IT portfolio governance must include people from all parts and varying levels of the organization, participating in both policy development and policy compliance. Participation breeds communication, which breeds comprehension, which breeds buy-in, which breeds compliance. Governance provides a structured forum for discussing and communicating the strategies, goals, priorities and principles of an organization, as well as the expected impact on the enterprise (Visitacion, 2003).

The most distinguishing and important characteristic of well-functioning IT portfolio governance is the existence of a true culture of portfolio management within the organization (Bonham, 2005). Culture, rather than business strategy or technologies, is the catalyst behind process and commitment. The heart of organizational culture is a common set of values that the entire organization believes in and adheres to. A healthy culture strives to create an organization wherein individuals are empowered and that promotes information facilitators and contributors, not controllers. In this environment, risk-taking is encouraged and failure is viewed as a learning opportunity. Culture is the key factor in successfully moving the value perceptions of the IT organization from cost center to value center.

Governance is evolutionary. Over time, more or less formal means of governance will be required to meet expected results. Ongoing measurement of governance policies and their impact on the enterprise is required to determine how governance must evolve. Effective IT portfolio governance is a key factor in achieving business value from IT investments and providing transparent pathways for different levels of involvement, decision making, and allocation and acceptance of responsibilities. It is critical to carefully think through the governance principles and processes implemented in an organization to ensure that they facilitate achievement of the business value sought from the organization's IT investments. The implemented principles and processes must be consistent with the business model, leadership culture and corporate governance policy and direction (Luftman, 1996). The IT portfolio governance policy must include all of the relevant governing principles, processes, management structures and performance metrics that enable business and IT executives to integrate business and technology planning and implement and monitor key business and technology initiatives.

Future Trends

According to The Standish Group (2003), less than 5% of Global 2000 corporations currently utilize portfolio management practices that manage business and IT investments as one portfolio. Today, many organizations are recognizing the value of embracing the portfolio management approach, which starts at the basic level of using portfolios as a communication vehicle (50% of the Global 2000) and evolves to utilizing portfolio management within the IT group on a sub-portfolio of IT assets (35% of the Global 2000). Organizations in the next, more advanced level of ITPM evolution holistically manage the entire set of IT investments as one portfolio across the entire IT organization (10% of the Global 2000) (Rosser & Potter, 2001). As more IT and business unit executives realize the strategic importance of ITPM, the above percentages are projected to increase significantly within the next 5 years. Even so, most organizations have a long way to go before they are able to truly create a highly collaborative, high-performing, enterprise-wide operation that optimizes the organization's portfolio of assets and projects.

There are many challenges to effective ITPM. Organizations that view IT as an expense rather than as an investment, will unlikely be able to reach more advanced levels of ITPM. In addition, according to Rosser and Potter (2001), 89% of companies today are flying blind, with virtually no portfolio metrics in place except for finance; 84% of companies either do not conduct business cases for any of their IT projects or perform them only on select, key projects; and 84% of companies are unable to adjust and realign their budgets with business needs more than once or twice a year.

Companies need to create a true culture of portfolio management within the organization before ITPM can be successful (Kerzner, 2001). Culture, rather than technology or business strategies, is the catalyst behind commitment and process. The aforementioned statistics suggest that commitment and process need to be greatly enhanced in many organizations before ITPM can have any lasting effect on the organization and its strategic objectives.

Conclusion

Strategic planning needs to be a continuous, collaborative process. Strategic planning is no longer a 5- or 10-year vision-setting exercise. It is a way of looking at conditions and initiatives that are just 1 to 3 years out. The process of strategic planning needs to occur continuously in organizations. The corporate strategic plan should serve as a commitment platform for IT initiatives (Heldey, 1997). Strategic planning needs to become a core competency of the organization for its long-term success. A strong CIO with vision is required to assist in building the strategic planning competency of the organization. Building stovepipes (one person does one thing, another person does another thing and they never talk), treating planning as an ad hoc process, making planning a one-time event and failing to measure initiatives will cause the organization fail in the strategic planning process. ITPM is a disciplined process that helps to ensure that the strategic planning process is successfully conducted, implemented and maintained.

ITPM is one of the most effective methods to reduce IT costs, yet maintain strategic value (Pastore, 2003). ITPM provides a process for selecting the highest-value initiatives and optimizing against budget, human resource, risk and other constraints. The benefits of the ITPM discipline are numerous. ITPM allows for unambiguous choices based on business impacts and measurable benefits. The ITPM process quantifies IT value by linking IT initiatives to the organization's business strategy, provides management accountability for realizing forecast benefits and provides a process to track and report on benefits realization.

ITPM requires that all IT-related costs be identified and classified using an effective IT asset inventory that facilitates accurate cost and value measurement. Adoption of a structured governance process and agreement across the enterprise on formal IT investment criteria are key to decision-making in a responsive approval process that is adaptable to changing business needs. The IT investment decision-making process must be defined and must consider short- and long-term impacts, cross-divisional impacts, business justification, benefit realization, strategic contribution, risk, compliance with regulatory mandates and conformity with technology architecture and direction.

ITPM is rapidly becoming an essential tool that enables business leaders to understand the visible impact IT operations have on business performance (Datz, 2003). IT synchronization with corporate business strategy is cited as the No. 1 concern of IT executives worldwide today. ITPM is increasingly recognized for its potential to support the continual alignment of business strategy and IT investment. As a result, leading corporations are placing a greater emphasis on ITPM as they attempt to make their enterprises more agile and competitive in today's global, hyper-competitive business environment.

Case Study: Harrah's Entertainment Inc.

Many organizations struggle to measure the real value of IT projects and assets in their portfolios. The IT and business leaders at Harrah's in Las Vegas have developed a system of IT portfolio management that provides for robust financial projections as well as monitoring, measuring and tracking capabilities. Harrah's utilizes this system to accurately estimate the costs and benefits of IT projects and to track the business value that they create.

Harrah's rigorous approach to IT portfolio management, with its built-in metrics, excellent execution and strong follow-up, has led to impressive performance. Project throughput has nearly tripled from 112 projects in 2001 to 324 in 2003. In 2003, the aggregate of projects in excess of $100,000 (88% of total IT expenditures) came in at 9% under budget. Seventy-seven percent of all projects came in on time, on budget and on target, while 83% hit two of those criteria. In comparison, The Standish Group reports that only 16.2% of IT projects, conducted in companies of comparable size to Harrah's, meet their time, budget and targeted performance objectives.

"It's a combination of structure and flexibility," says CIO Tim Stanley. "We have crisp operating procedures and structures, but we maintain the flexibility to constantly align with business, be responsive as things change, and really be able to go after the big hitters." Stanley says the success of Harrah's IT portfolio management process is largely about strategic alignment. "Alignment is, frankly, pretty hard," he says. And while aligning each business unit with IT is challenging, "pulling it all together into an overall corporate strategy is the secret to our success," Stanley says.

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Chapter IV

Relationship Between New Information Technologies and Flexible Organizational Forms

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Abstract

This chapter offers a theoretical investigation of the relationships between new IT and the implementation of emerging organizational designs. It argues that IT innovations can be regarded both as cause and consequence of the emergence of more flexible and virtual organizational forms. First, the authors offer a review of relevant previous literature, dealing with new IT, flexible organizational models and the relationships between IT and modular organizational structures. Next, a conceptual model is introduced that clarifies the relationships between IT development, the implementation of flexible organizational designs and environmental dynamism. Finally, conclusions and implications for researchers and practicing managers are presented.

Introduction

The transit from asset-based to information-intensive economies is forcing enterprises to continually generate and distribute knowledge to obtain a sustained competitive advantage. According to ongoing economical changes, traditional bureaucracies are proving inefficient to meet current competitive demands. This dynamic environment is characterized by an increasing development and organizational adoption of new IT.

From an organizational perspective, IT-adoption effects can be analyzed from the following points of view:

- First, the generalization of new IT, and mainly Internet-related technologies, is fostering the development of more dynamic business environments, which requires an efficient response from all market agents.
- On the other hand, pressures for flexibility are bringing about a continuous development of IT that meet companies' changing requirements of fast and efficient resource allocation.

The adjustment of business strategies to environmental conditions can be efficiently achieved, thanks to IT integration and the implementation of flexible organizational models. This chapter offers a conceptual analysis of the relationships between new IT and the implementation of emerging organizational designs.

Theoretical Background

In this section, a review of previous research is provided, exploring the main issues related to new digital technologies and evolving organizational models. This review offers the theoretical support needed for analyzing the effects of global information flows on structural building.

First, the main aspects of the RBV are presented as they relate to the establishment of flexible models, as opposed to the Transaction Cost Theory, which justifies classical bureaucratic models. The differential characteristics of new organizational designs are then depicted and compared to traditional models. Next, authors discuss the main issues related to the development and organizational adoption of new IT. Finally, a review of previous studies analyzing the relationships between both concepts is presented.

Resource-Based Theory and Flexible Models

The RBV argues that different competitive positions derive from each firm's unique bundle of resources and capabilities (Amit & Schoemaker, 1993; Barney, 1991; Barney, Wright, & Ketchen, 2001; Grant, 1991; Peteraf, 1993; Prahalad & Hamel, 1990; Wernerfelt, 1984, 1995). According to this view, a resource is an observable (but not necessarily tangible) asset that can be valued and traded, such as a brand, patent, parcel of land or license. A capability, on the other hand, is not observable (and hence necessarily intangible), cannot be valued and changes only as part of its entire unit (Makadok & Barney, 2001).

Resource selection and accumulation are, according to this view, a function of external strategic factors and internal business decisions. External influences include industry strategic variables, such as customers' or suppliers' power, competitive intensity or market structure, which affect firms' evolution in the markets. Internal decisions are mainly motivated by economic rationality, performance-related considerations and efficiency-related criteria (Conner, 1991). These factors influence the selection of certain resources over others, determining at the same time how they are finally deployed inside the organization.

However, not all resources can be a regarded as a source of sustained competitive advantage, but only those fulfilling certain conditions, which are referred to as "strategic assets" (Amit & Schoemaker, 1993). Following Barney (1991), to be a source of sustained competitive advantage, resources and capabilities must be:

1. **Valuable.** A valuable resource enables a firm to improve its market position compared to competitors.
2. **Rare.** To sustain competitive advantage, resources must be available in short supply relative to demand.
3. **Isolated from imitation or substitution.** To be rare, resources need to be immobile and costly to imitate or replicate.

Among these three characteristics, only value and inimitability are ultimately important. Rareness is relevant only if a resource is valuable, and exists only if the resource cannot be imitated by competitors. Therefore, the sustained competitive advantage is the result of rational discretion in managers' elections, the accumulation and selective disposition of resources, certain industry factors and market imperfections.

Only achieved competences allowing companies to generate new strategic assets faster and in a more efficient way than competitors will be a source of returns over the average. This superiority condition is determined by the way a company arranges its organizational structure. In this way, companies can efficiently share existing strategic assets and transfer the competences to develop new strategic assets in different organizational units (Markides & Williamson, 1996). This argument justifies the relevance of organizational structures under the RBV.

At the same time, environmental conditions, characterized by heterogeneity in inputs and demands, press companies inexorably towards organizational change (Schilling & Steensma, 2001). In such contexts, the classic bureaucratic perspective does not provide efficient answers. Traditional models manifest that the key to obtain and maintain a competitive advantage relies on codification and internal diffusion of innovations. This lack of performance is determined by economic transactions that imply knowledge transfer and codification and, hence, facilitates imitation (Child & McGrath, 2001).

Business activities imply continuous knowledge generation and, currently, it is only feasible through strategic flexibility (Sanchez, 1995).

The achievement of this flexibility becomes then a first-order strategic task, assuming that organizational structure and processes must be appropriate to their context (organizational culture, environment, technology, size or tasks), if it wants to survive or be effective (Drazin & Van-de-Ven, 1985) This theoretical exposition is widely reaffirmed in practice, with a myriad of companies adapting their organizational forms to give efficient answers to shifting the environmental requirements (Child & McGrath, 2001).

Traditional and Flexible Organizational Forms

The characteristics of these organizational forms are a focus of debate within the scientific community. Authors leading this emerging and spreading stream of research identify the existence of some structures substantially differentiated from the classical models. Due to the application of different approaches and the lack of an integrative paradigm, these models have been designated indistinctly as: virtual, flexible, modular, organic, hybrid, hyper-text, net-based, post-bureaucratic, ambidextrous organizations and so forth.

A review of existent literature evidences an increasing interest on this topic, which is exemplified by the appearance of several special issues in leading academic magazines delving deeply into the subject (e.g., *Academy of Management Journal*, 2001; *International Journal of Business in Economics*, 2002). However, a lack of agreement about the real situation becomes manifest, due to the non-existence of a stable theoretical foundation (Foss & Knudsen, 1996)

Diametrically opposed views can be identified on this issue. Certain positions defend the emergence of radically new organizational forms, both in terms of structure and cultural-psychological conditions (Bartlett & Ghoshal, 1993). On the contrary, other researchers deny the existence of differences between the multi-divisional forms identified by Chandler and the so-called "new organizational forms" (Gooderham & Ulset, 2002), while others affirm that even existing, classical integrated models keep performing better than emerging models do (Afuah, 2001).

With the aim of soothing extreme positions and establishing the bases for theoretical development, a large number of moderate works are currently being published (Bigley & Roberts, 2001; Child & McGrath, 2001; Foss, 2002; Laursen, 2002). They adopt an eclectic view, expressing the need for flexibility to survive in present-day contexts.

Traditional bureaucracies cannot efficiently perform in any of the three areas that organizational forms must cover: setting goals, resource flows' management, and companies' governance. The evolution toward information-intensive economies is introducing significant changes into the competitive context. As we argue later, the development and adoption of new IT can be regarded as one of the most important factors contributing to this shift. Under such conditions, to generate new knowledge in a continued way is the single way to obtain competitive advantage. Such knowledge flows cannot be efficiently developed with the totally regulated control structures that characterize bureaucracies.

However, enlarging our scope, it is possible to observe how the strategy-structure adjustment is not the single reason for flexible models' adoption. Assuming that wealth creation, in regimes of fast technological change, depends to a great extent on the capacity to internalize technological, organizational and directive processes, it is necessary to identify new opportunities. In this sense, the capability to organize them efficiently becomes more important than mere "strategization," which can be defined as "the implementation of strategies aiming at keeping current competitors away and excluding new entrants."

In this way, we use the term "dynamic capabilities," referring to the capability of acquiring new ways of competitive advantage. This definition highlights the two key aspects that compose this concept: The *dynamic* adjective makes reference to the capacity to renew competences coherently with the entrepreneurial changing environment. The word *capability* emphasizes the central role of strategic management in the adequate adoption, integration and reconfiguration of the organization to fulfill the changing requirements (Teece, Pisano, & Shuen, 1997)

Once the key aspects new organizational forms must cope with are analyzed, the next logical step would be to consider the essential characteristics shaping them. Existent literature offers a comparative perspective, describing these models and their characteristics with respect to the bureaucratic models.

Following this trend, Bartlett and Ghoshal (1993) delineated their model by explaining its fundamental differences with respect to the multidivisional form and other classical models. Three levels of analysis were established, centered on the roles to be accomplished by the company's managers. The principal conclusions of Bartlett and Goshal's paper are in Table 1.

In the same line of reasoning, Zenger (2002) argues that the principal characteristic of new organizations relates to the inclusion of market control elements in all levels of traditional hierarchies. Such mechanisms lead to the appearance of the so-called "hybrid organizations." It is argued that traditional hierarchies, characterized by functional organization,

Table 1. Characteristics of new organizational models

	Chandler	Bower	Cyert and March	New Model
Top management	Entrepreneur and resource allocator	Creator of structural context	Establisher of the Standard Operating Procedures and resolver of conflicts	Creator of purpose and challenger of status quo
Middle management	Administrative controller	Vertical information broker	Advocate of sub-unit goals	Horizontal information broker and capability integrator
Front-line management	Operational implementer	Initiator	Problem solver	Entrepreneur and performance driver

Source: Bartlett & Ghoshal (1993)

individual input measures and low-powered individual rewards, are involved in a three-level global change: Structural (autonomous work), Measures and Incentives (group-based payment). Therefore, traditional hierarchies, influenced by these practices, evolve into forms characterized by multi-functional teams and measures based on teams' output.

A complementary view is offered by Heiman and Nickerson (2002), centered on the development of external hybrids. These authors argue that in certain situations, knowledge-based practices can be applicable to interenterprise relations so that, from an external perspective, a hybrid between market and company is created.

In contrast with this theoretical conception, it is possible to find opposed positions. In Gooderham and Ulset's (2002) paper, they exclude the possibility of "crossbreeding" between the KBV and Transaction Cost Theory. They even argue that new organizational forms do not really exist. Rather, these can be considered as adaptations or variations of Multi-Divisional models (M-Form), which are supported by the Transaction Cost Theory.

Extending the previous proposition, Hodgson (2002), from a legalistic point of view, concluded that "company" and "market" are extremely different concepts, and therefore, they should be always differentiated. Hence, expressions like "company-market hybrids" or "markets inside the company" make no sense.

From a more descriptive perspective, Child and McGrath (2001) accomplish a comparison between classical forms (bureaucracies) and emerging flexible structures. They ground their paper on the three fundamental missions that must be facilitated by an organizational structure: setting goals, resource flows' management, and companies' governance. These contributions are summarized in Table 2.

Table 2. Conventional and emerging perspectives on organizational form

	Setting goals	**Resource flows' management**	**Companies' governance**
Bureaucratic models	Top-down goal setting Concentrated power Preference for larger units Leaders control through formal authority Hierarchy	Firm as unit of analysis Boundaries clearly specified and durable Vertical Rule-based Assets linked to organizational units	Specialized roles Clear role definition Relative permanence Efficiency oriented
New organizational forms	Decentralized goal setting Distributed power Preference for smaller units Leaders provide guidance Teams and work groups	Production system or network as primary unit of analysis Boundaries permeable and fuzzy Flexible Horizontal Relationship-based Structure independent of assets	General roles Fuzzy role definitions Impermanence Innovation oriented

Source: Child & McGrath (2001)

The characteristics of these models have been depicted according to different levels of analysis, ranging from the study of especially relevant cases in hypercompetitive markets (Bigley & Roberts, 2001; Malnight, 2001; Rindova & Kotha, 2001) to the generalized analysis of a specific sector (Afuah, 2001; Montoya-Weiss, Massey, & Song, 2001; Swaminathan, 2001) or intersectorial differences (Galunic & Eisenhardt, 2001; Laursen, 2002; Schilling & Steensma, 2001).

Development and Organizational Adoption of New Information Technologies

New IT has special characteristics that significantly change the way enterprises conceive business processes and relationships. One of the most important benefits provided by new digital services relates to the improvement of communication and information flows through interactivity and two-way communication. Both concepts are highly interrelated, and have been identified as differential characteristics of Internet-related technologies. Two types of interactivity are enabled by digital services (Berthon, Pitt, Katsikeas, & Berthon, 1999):

- Interactivity *with the medium* (e.g., interactively modifying the contents of a Web site).
- Interactivity *through the medium* (e.g., people interactions through the online media).

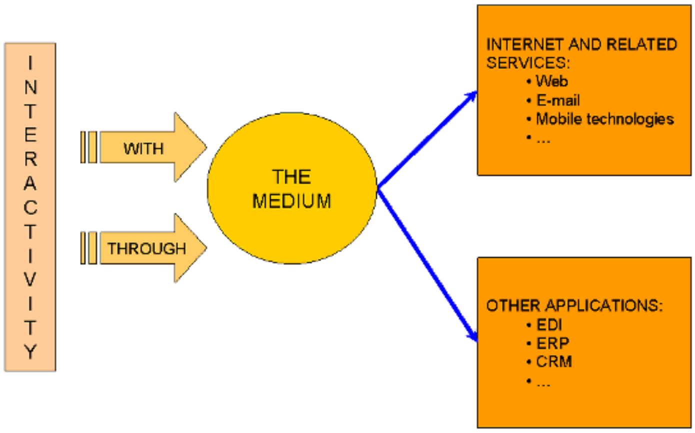
New information services foster direct and flexible communication inside and across organizations. Internet-related technologies enable both asynchronous and real-time communication, and global access to information at any time. Compared to traditional media, Internet services offer companies the possibility to quickly disseminate large volumes of information.

The main information technologies available for business communications include:

- The Internet and related services, such as the Web, e-mail, mobile technologies, newsletters, online forums, chat and messaging services and so forth, are powerful global communications tools. E-mail is currently the world's most widely-used online communications system between market institutions (Hamill, 1997; Wei, Ruys, van Hoof, & Combrink, 2001).
- Other technological applications are currently being used, like Electronic Data Interchange (EDI), Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Workflow and Groupware Systems, Intranets, Extranets and additional data transfer systems (Cavusgil, 2002; Rao, 2001).

New IT and the Internet provide great benefits for the integration of diverse management processes by enabling new ways to structure work and communication activities. These

Figure 1. Development and adoption of new information technologies



new information and communication capabilities overcome to a great extent time and space boundaries, thanks to the emergence of structures like *virtual teams*. According to Montoya-Weiss et al. (2001, p. 1251), "a global virtual team is a group of geographically and temporally dispersed individuals who are assembled via technology to accomplish an organizational task."

The development of decentralized work groups has great potential to integrate knowledge from different regions (Cavusgil, 2002). The use of Internet-based platforms can be very beneficial for management processes involving specialization and modular structures—for example, modular software design and decentralized R&D functions in multinational companies (Rao, 2001). According to Wymbs (2000), companies like Cisco Systems are using the Internet for the coordination of product design processes from geographically disperse research centers.

Among the streams of research exploring IT effects in organizational contexts, it is relevant to review studies into the antecedents and determinants of IT-organizational adoption (Harrison, Mykytyn Jr., & Riemenschneider, 1997; Huff & Munro, 1985; Thong, 1999; Tsikriktsis, Lanzolla, & Frohlich, 2004; Woiceshyn, 2000).

According to Thong (1999), the following factors influence the likelihood and extent of IT-adoption in organizations:

- Managers' characteristics, such as innovativeness and IT knowledge.
- Perceptions about IT characteristics, including relative advantage compared to previously existing systems, compatibility with existing behavioural patterns and complexity of the system.
- Organizational characteristics, like business size, employees' IT knowledge and information intensity of products and services.
- Environmental characteristics regarding market competition.

The likelihood of IT adoption was found to be positively associated with higher CEOs' innovativeness and IT knowledge, positive perceptions of the benefits of IT (relative advantage, compatibility and complexity) and two organizational characteristics (greater business size and employees' IT knowledge). One organizational characteristic (information intensity) and the environmental characteristic (competition) were not significantly related to the IT-adoption decision.

Although Internet uptake among businesses has not yet reached the penetration levels of more traditional communication channels (e.g., telephone or fax), the performance benefits of new IT is expected to increase substantially in the near future (Leek, Turnbull, & Naudé, 2003). While most traditional means of communication will be gradually replaced by more efficient ones, the application of IT-based methods may not be suitable for certain management processes. Rather, online and offline communication systems are expected to coexist in the future.

Antecedents on the Relationships Between IT Adoption and Flexible Organizational Forms

A recent stream of research focuses on the relationships between the adoption of new IT and flexible organizational forms. A high rate of technological change is positively related to the adoption of flexible organizational models (Afuah, 2001; Baldwin & Clark, 1997; Bartlett & Ghoshal, 1993; Montoya-Weiss et al., 2001; Schilling & Steensma, 2001).

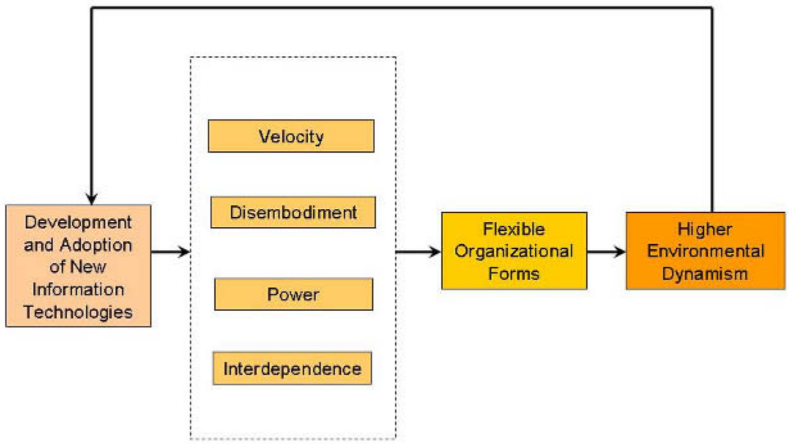
As a result of accelerations in the rates of innovation and technological change, markets evolve rapidly, products' life cycles get shorter and innovation becomes the main source of competitive advantage. Therefore, organizations seek flexibility to meet market demands.

Under environmental conditions of changing inputs and demands, technological change provides an additional incentive for the implementation of modular organizational forms, which enables the reallocation of heterogeneous resources in multiple configurations.

Additionally, a fast technological change can encourage organizations to specialize in order to benefit from the "learning curve" (Schilling & Steensma, 2001). In this regard, Afuah (2001) argues that facing a continuous technological shift, technologically non-integrated companies obtain performance improvements in the long term, compared to competitors. Nevertheless, the integration of companies on the basis of a specific technological system can be a source of short-term competitive benefits.

The hypothesis pointing to a positive relationship between the adoption of new information technologies and the development of flexible organizational forms provides the theoretical grounding for the development of the conceptual mode, presented in the following section.

Figure 2. Conceptual model



Conceptual Model: IT and Flexible Organizational Forms

In this section, the authors present a theoretical framework, exploring the interrelationships between IT development and flexible organizational forms. Figure 2 offers a graphical display of the main relationships included in the model. It is argued that IT organizational adoption facilitates and induces the selection of newer organizational forms, characterized by higher flexibility.

The development of new IT is regarded both as cause and consequence of the emergence of more flexible and virtual organizational forms. The implementation of IT has effects on companies' activities from two main points of view: First, newer IT facilitates companies' responses to environmental and competitive requirements; additionally, newer technologies can become a source of competitive advantage and differentiation.

IT-related competitive advantages do not only derive from access to different technological systems. More relevant to a company's competitive situation is the way IT is integrated into the company's value chain.

The conceptual model suggests that the potential of IT can be conceptualized in four environmental dimensions (*velocity, disembodiment, interdependence* and *power*), to which traditional organizational models do not offer an efficient response (Child & McGrath, 2001).

The changes introduced by the integration of IT into companies' activities are also expected to increase the dynamism of the business environment. More unstable scenarios foster continuous development of newer IT, which meet the changing requirements of current markets.

IT Development Effects on Environmental Challenges

High change and volatility rates pose significant challenges for the delimitation of a business strategy, aimed at an optimal adjustment to competitive conditions. Although multiple factors account for this dynamism, due to their current relevance and importance, we highlight the effects of new information and communications technologies, with Internet-related services as the most significant archetype.

Four dimensions allow defining the environmental problems companies need to overcome from an organizational point of view. These dimensions, identified by Child and McGrath (2001), include: *velocity, disembodiment, interdependence* and *power.*

In the proposed model, the development and organizational adoption of new IT exerts significant effects on each of the environmental dimensions. Next, these interrelationships are clarified.

Velocity

Velocity can be defined as "the pace at which changes take place in business environments." From an organizational point of view, the effects of increases in velocity include: reduction of market imperfections, volatility increases and shortening of necessary response times.

The establishment of market imperfections is highly influenced by the existence of information asymmetries. IT development provides the means for information access by a higher number of users. Though perfect markets can be regarded as a utopia, digital markets, where information is the interchanged good, represent an approximation to this theoretical concept.

Diverse technological innovations have modified competitive environments over time. Nevertheless, we are witnessing a progressive acceleration of innovations' development rates, which reduces to a great extent obsolescence periods. This situation is contributing to increase the business environment's volatility.

In this sense, the market evolution trends of wireless technologies can be pointed out. This represents the technological platform with one of the highest development and application potentials. The estimated growth in the global m-commerce market is around 75% annually, and is expected to reach $80,000 million by the end of 2005. Globally, market estimates suggest that around 1,000 million people would use mobile technologies for data exchanges by the end of 2005. In 1999, there were only 26 million users of mobile appliances (Accenture, 2002).

New IT provides higher information transfer capacities, both in terms of volumes of information and time or geographic availability. The integration of such technologies into the value chain enables companies to give a more efficient response to stakeholders' demands. Therefore, it is argued that the generalized integration and adoption of new information technologies leads to increases in the degree of environmental velocity.

Disembodiment

The term *disembodiment* refers to the breaking-off of the direct relationship between the physical ownership of the asset and the benefits derived from its use.

Current markets are increasingly characterized by higher relevance of "virtual assets," such as information and technological skills, fast and global information flows, digital and network resources, and the technological integration of global operations, as sources of competitive advantage.

Internet technologies are a clear example of the way IT enables disembodiment. Such digital services are allowing companies to provide a wide variety of *mass customized* services without staff involvement. Nevertheless, virtual managers should not regard the possibilities for standardization and mechanization as a panacea for replacing all personal interactions.

In addition, new IT contributes to an increasing industrialization and automation of processes, which can be considered as a prerequisite for the establishment of modular organizational designs. For instance, new digital technologies improve to a great extent information acquisition processes.

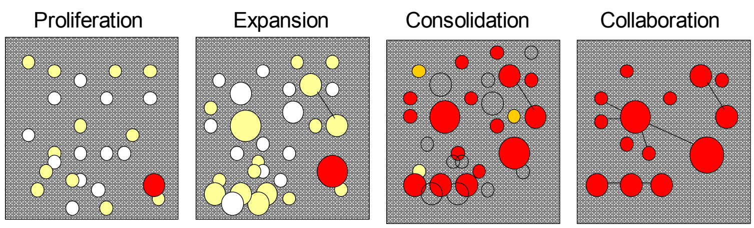
Power

In business relations, it is important to define the sources **power** derives from, whether ownership of tangible assets and inputs or possession of knowledge and information.

IT development and integration is contributing to a higher relevance of information-based assets. It does not imply a reduction of power asymmetries, but a shift in the focus of power.

To understand the effect of new IT on the distribution of power in a specific market, the work of Brooks and Cantrell (2000) is reviewed. This study clarifies how changes in the power nodes take place in B2B e-markets, a context highly influenced by new technologies and the ownership of information assets.

Figure 3. Power distribution in B2B e-markets



Source: Brooks & Cantrell (2000)

According to these authors, activity within the B2B e-market space will go through four general phases over time: proliferation, expansion, consolidation and collaboration. These stages are denoted by different power configurations in the market, from an initial step—characterized by a high number of new competitors—where power is equally distributed between most members, to a final phase with less number of participants but greater sales volumes. Therefore, there is a trend towards the concentration of power in few big-sized but interconnected companies.

Interdependence

Interdependence refers to a reciprocal relation between mutually dependent institutions. It suggests that a single company's business decisions induce reactions in the business network chain. Situations of high business interdependence are characterized by problems in the coordination of activities and processes.

New IT facilitates higher proximity and interactivity of business processes, which enables the development of internal and external communication flows. Growing IT implementation is contributing to increase the importance of strongly collaborative commercial forms.

The concept of "extended company" exemplifies the impact of IT on organizational structure. This kind of *virtual* form allows companies to adopt a global conception of their businesses by integrating their value chain into the market's value system. In this way, competition takes place, to a higher extent, among value systems, rather than between isolated companies.

Network relationships are critical for success in information-intensive markets. Wymbs (2000) suggests that the value of business networks grows consistent with Metcalfe's Law: "The value of the network is equivalent to the square of the number of nodes connected to it." As a consequence, the global nature of the Internet increases the number of potential relationships, which have revealed increasing relevance in achieving a sustained competitive advantage.

Activities susceptible to integration by the development of business networks include collaboration with providers and customers in processes such as: forward planning, product design and development, inventory management, production and logistics.

In line with the Transaction Cost Theory, the Internet is reversing the trend of internal development of all needed processes (departmentalization and size increases) towards specialized network relationships. In this sense, new IT significantly reduces transaction costs between companies, favoring specialization around core capacities, outsourcing of non-central activities, and development of modular and net structures. Therefore, it leads to increases in environmental interdependence.

The development of diverse IT influences the degree of business interdependence. Among these technologies, we highlight the importance of ERP software solutions: These systems manage all the information flows, from their origin on the demand side to the activities along the value chain.

Also, recent peer-to-peer (P2P) software applications offer great potential for the management of interorganizational processes. File-sharing software's underlying technology can become a valuable source of competitive advantage in the future. In particular, P2P systems can be very useful in situations requiring the participation of different companies. In this case, it is possible to share only the needed information for the development of a specific activity, ensuring at the same time the independence of processes not involved in the collaborative activity.

Organizational Responses to Environmental Challenges

Velocity

To manage the current technological change rates, innovation and the creation of new capabilities have become essential requisites to overcome the information intensity of business interactions (Rindova & Kotha, 2001). To meet the demands of speed, flexibility becomes indispensable to survive in contemporary commercial scenarios.

Therefore, resources must be arranged in ways that contribute to shorten response times. This can be achieved through (Galunic & Eisenhardt, 2001):

- Modular structures.
- A culture that enables internal competition, as well as cooperation capabilities to overcome the potential negative effects of that competition.
- The establishment of dynamic capabilities, guided by simple rules.
- Leadership, practiced by corporative managers acting as architects, entrepreneurs and guardians of the corporate culture.

These arguments are consistent with the findings of Rindova and Kotha (2001), who, following population ecology principles, argue that the key to survival in highly dynamic environments relates to a deep and continuous organizational change; and the findings of Schilling and Steensma (2001), who propose modular models as effective responses to environmental pressures towards flexibility.

Disembodiment

IT development is enabling (as argued in the previous section) the adoption of organizational models that seize the possibilities of disembodiment. In this regard, organizations are conceived from a wider perspective, which integrates not only physically owned assets in the company, but all those value-adding resources in their productive activities.

Practical Application: Disembodiment

Volkswagen has taken this approach (modularity) even further in its truck factory in Resende, Brazil. The company provides the factory where all modules are built and the trucks are assembled, but the independent suppliers obtain their own materials and hire their own workforces to build the separate modules. Volkswagen does not "make" the car, in the sense of producing or assembling it. But it does establish the architecture of the production process and the interfaces between cells, it sets the standards for quality that each supplier must meet, and it tests the modules and the trucks as they proceed from stage to stage.

Source: (Baldwin & Clark, 1997)

Nevertheless, to take advantage of the potential benefits of flexibility provided by modular organizational structures, managers need to establish a system of standards enabling coordination.

This conclusion is applicable to the case of virtual work teams, which represents a clear example of the organizational use of asynchrony and dispersion-related benefits provided by new IT. Such virtual teams are characterized by the participation of people who can operate without time or space restrictions. Potential problems derived from the peculiarities of virtual teams can be solved by the establishment of temporal coordination mechanisms.

Power

Power, which, in the traditional bureaucracy was presumed to be held by top executives, becomes a far more complex matter in organizations integrating multiple stakeholders and presenting horizontal structures.

From the Agency Theory perspective, the solution would be to align the interests of all members of the organization to avoid asymmetry disadvantages. This can be achieved

Practical Application: Power.

Modularity does more than accelerate the pace of change or heighten competitive pressures. It also transforms relations among companies. Module designers rapidly move in and out of joint ventures, technology alliances, subcontracts, employment agreements and financial arrangements as they compete in a relentless race to innovate. In such markets, revenue and profits are far more dispersed than they would be in traditional industries. Even such companies as Intel and Microsoft, which have substantial market power by virtue of their control over key subsets of visible information, account for less of the total market value of all computer companies than industry leaders typically do. Being part of a shifting modular cluster of hundreds of companies in a constantly innovating industry is different from being one of a few dominant companies in a stable industry.

Source: (Baldwin & Clark, 1997)

by the application of diverse non-bureaucratic principles, such as the substitution of the merely contractual nexus by more advanced practices, like decentralization of responsibilities, ensuring empowerment and identification with the general principles of the company (Ashcraft, 2001).

Nevertheless, delving deeply in our research scope, it is possible to observe how the strategy-structure adjustment is not the only motivation for flexible models' adoption. On the contrary, wealth generation depends to a great extent on the ability to internalize technological, organizational and management processes.

Interdependence

Interdependence suggests that a company's decision causes chain reactions in business networks that may lead to coordination problems. In this regard, modular organizational forms can facilitate coordination and flexibility in the presence of environmental changes. This view of modularity, alternative to Williamson (1975), argues that now companies' competitive advantages are not based on variety, originated by the existence of multiple strategic business units. Rather, advantages derive from the recombination of diverse divisional resources to quickly respond to customer needs and environmental conditions (Schilling & Steensma, 2001).

"Virtual, extended or net-based companies" emerge as an efficient response to problems related to global resources coordination. Virtual companies are grounded on three basic elements: integration of internal and external processes, automation and collaboration.

Integration ensures transparency in transactions, according to previously agreed terms. Automation provides all net partners the needed mechanisms to efficiently contribute their added value. Finally, collaboration assures that all stakeholders' interests are considered, some of which can be apparently contradictory. Managers' responsibility lies in ensuring that these nets are effectively connected to each other.

Practical Application: Interdependence.

Processes aiming organizational flexibilization have been common to luxury fashion companies. For firms like Ralph Lauren, Calvin Klein or Donna Karan, managing the brand has thus implied much more than simple attention to the quality and consistency of products and services. It has meant ensuring the overall coherence of the script, articulating a series of interdependent sequences of events, selecting some, dropping others, arranging and rearranging them, according to changing conditions and needs. These companies have not been afraid of complex organizational arrangements consisting of large numbers of relatively autonomous modules. They can be described as "hubs," where the core competence is the coordination and management of interfaces between modules.

To reach a satisfactory level of control, American fashion companies have had to foster and bring about a degree of standardization between these interfaces. They have done so by setting clear and detailed sets of instructions to map out the work of subcontractors and partners, but also by defining strict quality standards, deadlines and control procedures. It has been possible through the integration of sophisticated information systems.

Source: (Djelic & Ainamo, 1999)

Effect of Higher Environmental Dynamism on New Technologies' Development

As previously discussed, a higher organizational use of new IT induces increases in the competitive dynamism. In the proposed conceptual model, environmental volatility has been captured in four dimensions.

Higher environmental uncertainty exerts a positive feedback effect on IT-innovation processes, needed to meet companies' changing IT-related demands. As a consequence, the conceptual model is conceived as a Schumpeterian cycle, describing a process of continuous knowledge generation and adoption of technological innovations.

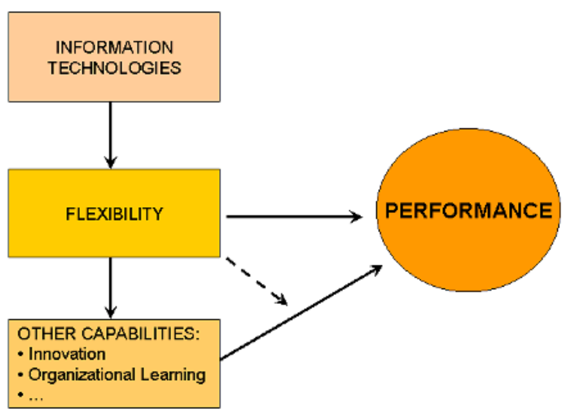
Model Effects on Performance

Performance effects can be regarded as some of the main implications for researchers and, especially, practicing managers. In this sense, the contributions of flexible organizational structures to performance are likely to encourage their implementation in business practice.

In addition to tangible benefits, a company's innovation-related capacities are also argued to increase their potential to obtain intangible returns. Among non-tangible benefits, we highlight organizational flexibility (Noori, 1990), which is regarded as a return of the innovation.

In addition, flexibility can act as a complementary asset to other company capabilities, like innovation and organizational learning. Teece et al. (1997) introduced the concept of "complementary assets," defined as resources or capabilities that allow capturing the benefits associated with a strategy, technology or innovation. In a similar way, other

Figure 4. Model effects on performance



authors (Grant, 1996; Kogut & Zander, 1992) have developed this idea, arguing that the existence of complementary assets can contribute to the sustainability of competitive advantage, if competitors cannot obtain benefit from them.

Flexible organizational structures are influenced, therefore, by new IT, which represent a new source of organizational knowledge generation. Besides, as suggested by Fiol and Lyles (1985) and Hage (1998), centralized structures block learning processes as they tend to reinforce the past, while decentralized structures allow faster changes. Thus, organizational flexibility fosters learning processes and related advantages.

From an organizational learning perspective, different authors have argued that knowledge-based assets can generate economical returns and be a source of sustained competitive advantage (Lado & Zhang, 1998; Nonaka, 1991; Slater & Narver, 1995; Slocum, Mcgill, & Lei, 1994; Stata, 1989).

As a conclusion, organizational flexibility can be expected to have positive effects on performance. Therefore, researchers and managers should be aware of the relevance of this capability. Likewise, factors favoring the development of this capability must be reinforced, especially the implementation of new IT.

Future Trends

During the past years, there has been increasing interest among academics to analyze the usefulness of flexible forms in coping with competitive pressures. Due to the relative immaturity of this stream of research, several relevant topics deserve further attention by the academic community.

Being one of the purposes of the current chapter, a widely accepted conceptualization of "flexible organizational forms" is needed. Previous literature evidences a partial approach to this global phenomenon. The lack of clear definitions hinders the development of further studies on this topic.

The continuous development of theoretical studies will provide the necessary basis for later empirical investigations, validating and generalizing the proposed theoretical relationships. Future research should focus, among others, on the following issues:

- Industry-specific studies, to better understand the interrelationships between IT adoption and flexible forms in different competitive contexts.
- Inclusion of additional factors determining the adoption of virtual forms, going beyond pure rational dimensions (e.g., social and institutional variables).
- Alternative conceptualizations of environmental dynamism, which facilitates a better understanding of current markets' complexity.
- Application of alternative theoretical approaches, such as the Resource-Based Theory, the Agency Theory, Population Ecology and so forth. This would clarify if the findings are consistent across diverse conceptual frameworks.

Conclusion and Implications

This chapter has provided a conceptual framework, dealing with the relationships of new digital technologies and flexible organizational forms. The integration of previous research and the proposed conceptual model should be valuable both for academics and practicing managers.

The analysis of the usefulness of flexible organizational forms in highly technological contexts derives, to a great extent, from the lack of efficiency provided by traditional bureaucratic organizational models. In this regard, it is evident that new IT is critical for the development of flexible structures.

In the proposed conceptual model, new IT is considered to have dual implications: While IT facilitates the adoption of flexible organizational models, they also have a "dynamizing effect," which increases the degree of volatility in the markets.

The model captures environmental heterogeneity in four dimensions, previously identified by Child and McGrath (2001): *velocity, disembodiment, interdependence* and *power*. The theoretical model is grounded on the analysis of IT development influences on flexible organizational models, through the previous four dimensions.

The high change rates caused by the development of new IT is modifying the way companies conceive business nowadays. The generalized IT integration and adoption increases environmental velocity. Companies must adjust quickly to these continuous shifts, making necessary the development and implementation of structures that enable a high degree of flexibility and adaptability in strategic resource allocation. According to previous studies (Galunic & Eisenhardt, 2001; Rindova & Kotha, 2001; Schilling & Steensma, 2001), modular models offer adequate responses in such contexts.

The peculiarities of IT are inducing changes in traditional markets, which contribute to a transition from an asset-based economy to a higher relative importance of virtual assets. These changes increase the degree of disembodiment in the competitive environment. To take advantage from these changes, virtual organizations provide the needed coordination mechanisms to maximize incorporeity-derived benefits.

Table 3. IT effects on environment

VELOCITY • Reduction of market imperfections • Volatility increases • Shortening of necessary response times	DISEMBODIMENT • Higher relevance of virtual assets • Mass customization • Automation of processes
POWER • Higher relevance of information-based assets • Focus shift	INTERDEPENDENCE • Higher proximity and interactivity • Development of internal and external communication flows • Importance of collaborative commercial forms

Table 4. Environmental challenges for organizational forms

VELOCITY • Continuous change • Modular structures • Key role of culture and leadership • Dynamic capabilities guided by simple rules	DISEMBODIMENT • Integrating all value-adding assets (not only physically owned) • Need to establish system of standards
POWER • Integrating multiple stakeholders • Avoiding asymmetry disadvantages Ability to internalize technological, organization and management processes	INTERDEPENDENCE • Integration of internal and external processes • Automation • Collaboration

IT influences on competitive markets' power configuration, as presented in the conceptual model, has been exemplified through the evolution of B2B electronic markets. In this context, power shifts are expected, from an initial situation with equal distribution of power between market members to a final phase with a higher degree of power concentration. The integration of multiple stakeholders' demands needs to be effectively managed. More advanced organizational practices (other than purely contractual relationships), such as decentralization of responsibilities, empowerment and identification with the general principles of the company (Ashcraft, 2001), can be very beneficial in managing current power reconfiguration processes.

The increasing IT implementation in organizations is contributing to a higher relative importance of commercial forms characterized by higher collaboration. Increased interdependence is an emergent characteristic of current markets. In this sense, the appearance of "extended companies" is a clear example of IT impacts on organizational structure. This kind of virtual structures enable companies to have a global concept of their businesses, integrating their value chain into the market's value system. As a result, competition takes place, to a higher extent, among value systems rather than between isolated companies.

With regard to the IT adoption and integration effects, the mere access to and use of such digital services cannot be regarded as a direct source of sustained competitive advantage. Rather, IT usage will be a must for the survival of most companies, which is consistent with Barney's Resource-Based Theory.

As a final conclusion, we would like to point out that, although new flexible forms encourage firms to obtain commitment from all organization members through empowerment and decentralization, virtual organizations facilitate, at the same time, impersonal transactions through "e-commerce" and other boundaryless contracting forms. In this regard, virtual managers should not consider the possibilities for standardization and mechanization as a panacea for replacing the need for personal interaction, but a great way to enhance the enterprise's potential.

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Section II:

Processes and Capabilities

Chapter V

IT-Enabled Strategy: Implications for Firm Performance?

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Abstract

The rapid evolution of IT has enabled new organizational capabilities to manage knowledge and information. Given this evolution, IT systems for enabling the acquisition, processing and dissemination of knowledge may present unique opportunities, if effectively leveraged, for firm competitive capabilities. This chapter examines some of these uses of IT; offers a framework to view firm activities as knowledge Inflow, Intraflow *and* Outflow *processes; and explores possible performance implications of some potential IT-enabled capabilities. Such IT enablement challenges some existing views of strategic management theory and suggests that theory may need to be reexamined and extended to handle some implications arising from advances in IT systems. We explore potential implications of IT-enabled capability and argue that through adopting, integrating and effectively leveraging these capabilities, firms may have the opportunity to enhance their competitive advantages and performance.*

Introduction

Information processing and knowledge management (KM) systems have seen a significant evolution over the past decade. As management research from a knowledge-base view (KBV) links the competitive advantage of an organization to individual tacit knowledge (Kogut & Zander, 1992; Grant, 1996), what impact has this rapid evolution in IT capabilities, and the resultant increase in organizational abilities to now codify and more effectively acquire, store and transfer knowledge, had on firms and their performance? These changes in management information systems (MIS) capabilities may also provide cause to reexamine some of our theories and accepted views of the bounds of organizational capabilities based upon knowledge. Specifically, if a firm's KM systems are significantly augmented in terms of their capabilities for data acquisition, codification and combinative capabilities, what are the theoretical implications of the sustainability of competitive advantages and firm performance based upon such knowledge? These are the issues and implications explored in this chapter.

In this chapter, we explore IT-enabled means of acquisition of data and information, and systems for conversion of information into actionable knowledge. This is conducted through exploration of the potential impacts of KM technology in combination with variations of IT systems infrastructure. We are specifically interested in exploring the potential implications for firm performance through mediating or moderating relationships of IT resources on firm knowledge flows. We discuss how IT systems may enable organizations to more effectively acquire, codify, aggregate and allocate competitive knowledge. Through this discussion, we review common competency-based perspectives of strategic management. From this theoretical basis, we develop propositions regarding whether IT-enabled knowledge capabilities should lead to increased performance or a corresponding decrease in the firm's ability to sustain competitive advantage on that knowledge. To facilitate this, the chapter provides a brief review of research on related IT applications and platforms in the context of organizational KM processes, and then explores theoretical implications of IT-enabled KM on firm competitive advantage and performance.

Issues, Controversies, Problems

The Evolution of IT-Enabled KM Capability

IT knowledge systems have evolved significantly over the past decade. These include a wide variety of approaches, which range from simple e-mail and groupware collaboration tools to extensible markup language (XML)-based workflow management systems, knowledge repository networks and aggregated knowledge portals, to complex Online Analytical Processing (OLAP)-based customer data warehouse (CRM) and data mining/ business intelligence (BI) and alerting systems. Regardless of the technical system, common threads exist across IT platforms and applications. Among current and recent generational systems, these include relational database central processes, XML- and Java-based open architectures, and fairly transparent workflow management (WFM) capabilities. These solutions are significantly advanced from previous systems of only a few years ago, and the MIS field has been actively attempting to address limitations of the models underlying these technical systems.

Current generational databases have benefited from extensive theoretical advances in the areas of database design (Dey, Sarkar & De, 1998; ; Storey, Chiang, Dey, Goldstein, & Sundaresan, 1997; Storey & Dey, 2002) and database design cost-benefit considerations (Dey et al., 1998). Further, current-generation databases are more capable of handling entity matching and semantic heterogeneity, which is a key issue facing organizations with both cross-generational legacy technology and in the management of knowledge inflows. Object-oriented database approaches (Dey, Sarkar, & De, 2002), as well as significant advances using decision theoretic (Dey et al., 1998, 2002), and algebraic and probabilistic solutions to these issues (Dey & Sarkar, 1996, 2000) have also been advanced, which may benefit current and future generation databases. Therefore, the existence of prior- or current-generation databases may significantly moderate the effectiveness of current-generation IT, such as CRM systems, on the organization's ability to acquire information and generate knowledge (customer analytics), as well as create knowledge outflows to improve sales (such as sales force automation and targeted marketing campaigns). For example, based on these database system advances, we can assume that CRM systems built upon modern CDW or relational database management systems (RDBMS) systems should be more effective for KM capability than implementations less effectively integrated to online transaction processing (OLTP), or CRM implementations on older non-RDBMS systems.

IT systems also deal with the information and business process workflows that underlie the organization's activities. Advances in this area from the MIS literature include extensive analysis and conceptual introductions of modern workflow management systems (WFMS) (Bussler, 1999; Georgakopoulos, Hornick, & Sheth, 1995), as well as significant improvements in the codification and modeling of workflows (Aalst, 1998; Basu & Blanning, 2000). Of particular interest to management scholars may be findings that inter-firm and cross-organization interactions may also rely heavily on the seamless, transparent and automated exchange of information facilitated through inter-organizational workflow systems that have been advanced in recent MIS literature (Aalst & Kumar, 2003; Klingeman, Wasch, & Aberer, 1998). Additional research indicates that knowledge flows are also dependent upon open-architecture solutions and e-service platforms to facilitate inter- and intra- workflows via the Internet as evidenced through discussions of exchange and XML-based solution propositions in recent literature (Basu & Kumar, 2002; Casati & Shan, 2001).

These IT advances in the workflow area may be quite timely. Inherent uncertainty in the exogenous, real-world environment forces business decisions to be made with uncertain data and incomplete information. IT-enabled knowledge systems, based on these improved databases and workflow systems, may be utilized to provide actionable knowledge to more effectively support managerial decision making under prevalent conditions of uncertainty. These and other advances in database and workflow technology have and will enable an organization's knowledge acquisition, codification, analysis and transfer capabilities. This, in turn, may significantly enable more effective knowledge-based competitive advantages for some organizations. Further, organizations not utilizing such current-generation KM technology may likely have redundant data collection activities, difficulty sharing information between groups within the firm, and difficulty enforcing and standardizing workflows. Therefore, current-generation KM systems may be fairly reliant on the presence of current- or recent-generation WFMS-type systems to facilitate KM capabilities. However, to make more sense of the potential implications of these KM technology advances, we need to first explore the theoretical mechanisms through which they may contribute to the firm.

IT-Enabled Capability and Strategic Management Theory

What impact have these advances in IT capability had on firms' abilities to manage knowledge, and what implications might a continuing advance of IT-enabled knowledge capabilities hold for strategic management theory? Specifically, what are the theoretical implications of a firm's ability to now more effectively acquire, process, store and transfer knowledge on the sustainability of competitive advantages and firm performance based upon such knowledge?

The management field's current theoretical treatment of knowledge may perhaps be best viewed through common competency-based theoretical perspectives, such as the RBV and KBV of the firm (Barney, 1991; Grant, 1996; Kogut & Zander, 1992; Wernerfelt, 1984). In these views, RBV deals with the potential for a firm's resources to generate sustained competitive advantage if the resource is: (1) valuable; (2) rare; (3) imperfectly imitable; and (4) non-substitutable (Barney, 1991). Whereas KBV, as an outgrowth of resource-base view (RBV), treats individual or organizational knowledge as a distinctively unique resource that is the true source of sustained competitive advantage in organizations (Grant, 1996; Kogut & Zander, 1992).

Extensions of KBV have argued that the ability to transfer knowledge within the firm is a critical component of an organization's ability to build competitive advantage and appropriate rents from internal knowledge resources (Szulanski, 1996). While such competencies and/or knowledge are ideally imperfectly imitable by a firm's competitors, they are also then by nature difficult to imitate internally, and may therefore represent a limiting factor on a firm's competitive advantage if methods of effective intra-firm knowledge transfer are not institutionalized or technically enhanced. Therefore, increased adoption of modern IT-enabled KM systems could facilitate an increase in organizational knowledge flow. Further, organizations adopting these IT-enabled knowledge systems could, therefore, potentially experience increased performance. However, where, when and how should IT systems align with an organization's knowledge processes to potentially result in such IT-enabled capabilities?

Solutions and Recommendations

A wide body of literature from various academic disciplines has attempted to explore and address issues of knowledge acquisition and learning processes within organizations. Some common historical perspectives may treat knowledge as a specific static construct that must be uniquely constructed. More recent research advocates examining KM from an organizational capabilities perspective (Gold, Malhotra, & Segars, 2001). This suggests that knowledge infrastructure should consist of technology as well as a supportive organizational structure and culture to effectively facilitate acquiring, processing, applying and protecting knowledge (Gold et al., 2001).

Along these lines, we suggest that one possible solution approach to better understand how IT may enhance or enable organization capabilities may be to adopt the perspective utilized in the KBV (Grant, 1996; Kogut & Zander, 1992). This perspective views knowledge as more of a complex creation evolving from data and information. KBV perspectives of KM focus on issues of how knowledge is acquired, where knowledge is stored, how learning takes place and how knowledge is transferred. Despite extensive work on knowledge and organizational capability topics, few studies have specifically or effectively addressed knowledge acquisition and transfer processes within an organization in terms of their effects on organizational performance metrics.

Organizational KM Processes

As recent work (Argote, 2000) rationalizes that technical systems may be one of the most effective means of acquiring, storing and transferring knowledge between individuals and organizations, this chapter addresses this gap by examining firm performance implications of organizational knowledge processes supported through such systems. To facilitate this approach, we design a simplified taxonomy to group organizational knowledge processes and their related IT systems into three categories based on the type of knowledge process. This simple typology is applicable to either information or

Table 1. Knowledge flow typology

	Inflows	Intraflows	Outflows
Knowledge Management Process	Knowledge search and acquisition	Knowledge codification, aggregation, recombination and intra-firm transfer	Knowledge allocation, deployment, inter-firm transfers and leakage
Information Source and Flow	External information and new hires	Internal existing data and employees	Organization
Technical System Support Applications	External databases, CRM, OLTP, open and proprietary Internet, extranets and CI systems	Internal databases, OLAP, WFMS, ERP, ELS, BI tools, Intranets, collaboration tools, e-mail/exchange systems	INET, B2B and business-to-consumer (B2C) exchanges, hubs, information security, cross-organizational WFMS and extranets

knowledge flows through the organization. It consists of knowledge flows into the organization (*Inflows*), knowledge flows within the organization (*Intraflow*) and knowledge flowing out of the organization (*Outflows*). The knowledge flow typology is depicted in Table 1.

Organizational Knowledge Inflows

Organizational knowledge inflows consist of data and information entering the organization from multiple external sources and channels, which the organization can convert to actionable knowledge. Inflows can also consist of external knowledge entering the organization through the acquisition of new individuals or interactions with individuals external to the organization.

IT systems supporting knowledge and information search and acquisition activities include external open and proprietary Internet resources and databases, online transaction processing systems for the collection of customer data, CRM systems for the analysis and handling of customer information flows to the organization, and competitive intelligence (CI) tools for acquiring and analyzing competitive information. While these systems tend to be more current, the presence of previous-generation workflow management systems as well as legacy databases and related OLTP systems in the organization may complement the effectiveness of these systems.

Therefore, leveraging a KBV perspective of treating acquired information or knowledge as a resource, and utilizing such enabling technologies to enhance the knowledge acquisition (*inflow*) processes, we make the following proposition:

Proposition #1: *Firms utilizing IT-enabled information and knowledge acquisition capabilities, in conjunction with complementary supporting technology and processes, will experience increased knowledge inflows and the benefits corresponding to these knowledge flows, compared to firms not utilizing IT-enabled information and knowledge acquisition capabilities.*

Organizational Knowledge Intraflows

Internal information flows deal with the processes of codifying, aggregating and recombining internalized information and knowledge for transfer within the organization. Complex knowledge may require IT systems for its effective codification and deployment. Knowledge requiring high internal transferability should greatly enhance organizational performance when flows are facilitated through technical systems. However, much of the valuable knowledge is usually tacit by nature, and historically has been difficult or impossible to codify until the recent advances of modern KM technologies. Further, once codified, if the knowledge is proprietary or strategic to the firm, it must also be protected and secured to avoid its potential loss and possible resulting harm to the firm. Therefore, trade-offs must be evaluated if the organization also depends on the internal transferability of strategic and proprietary knowledge.

IT systems that support internal knowledge processes include current RDBMS and prior-generation internal databases, as well as RDBMS-based customer-centric data warehouses, OLAP systems and analytical CRM/data mining/BI analysis tools. Further, intranets, knowledge repositories, collaboration tools and e-mail systems may also facilitate the intraorganizational exchange of information and knowledge. WFMS may also be employed to manage and reengineer the information system processes that underlie business activities. WFMS-type application platforms, such as Enterprise Learning Systems (ELS), are also utilized to store and manage the flow of organizational and external knowledge to and among individuals in much the same manner as enterprise resource planning (ERP) systems manage resource flows, production processes and personnel within organizations.

While it is often evidenced in system integration projects that cross-generational intra-firm legacy technology may likely serve as a constraint preventing the effective integration or full utilization of current-generation systems capabilities, some generational technology mixes may actually support intra-firm knowledge flows. For example, cross-generational technology may complement modern *intraflow* technologies by providing both a data source and repository from legacy data warehouses and WFMS-type ELS and ERP platforms for modern analytical CRM (eCRM) and analytic tools to interact with and to search, recombine and deploy intraorganizational knowledge.

Therefore, leveraging KBV perspectives on the role of generating and transferring knowledge within the organization as a means of increasing firm performance, and given technology's ability to enhance these activities, we make the following proposition regarding IT-enabled (*intraflow*) processes and firm performance:

Proposition #2: *Firms utilizing IT-enabled information and knowledge analysis and processing capabilities, in the presence of some technology combinations and supportive organizational processes, will experience increased intra-firm knowledge flows and knowledge generation benefits, compared to firms not utilizing IT-enabled information and knowledge analysis and processing capabilities, or firms utilizing it in non-supportive technological environments.*

Organizational Knowledge Outflows

Knowledge outflows consist of the firm's efforts to organize, recombine and deploy knowledge assets to create and support revenue-generating activities and opportunities for the organization. These processes may involve the exploitation of opportunities; strategic communication and positioning activities; and interactions with customers, partners, suppliers and competitors in the external environment.

IT systems supporting these activities include business to business (B2B), business to consumer (B2C) and business-to-government (B2G), public and private exchanges, Internet sales channels, cross-organizational workflow platforms and extranets. The control and protection of such flows from unwanted extra-firm knowledge transfers and leakage may also be moderated or deterred to some extent through the use of information security (INFOSEC). The existence of high degrees of IT cross-generational heterogeneity and/or extensive use of legacy-generation technology may present substantial constraints to desired knowledge outflows (limited capabilities and managed control of outflows) while challenging current-generation information security and facilitating unwanted extra-firm knowledge flows (leakage).

Therefore, based upon the KBV-motivated perspective that codified or partially codified tacit knowledge and information leakage will undermine firm sustainable competitive advantage (Grant, 1996; Kogut & Zander, 1992), as well as RBV motivations on the importance of resource rareness, value, inimitability and cost to substitute (Barney, 1991), and the technology's ability to facilitate as well as deter leakage, we make the following proposition regarding IT-enabled *outflow* processes and firm performance:

Proposition #3: *Firms utilizing IT-enabled information and knowledge dissemination capabilities, in the presence of some technology combinations and supportive organizational processes, should experience increased productive knowledge outflows. If unwanted extra-firm knowledge outflows (leakage) are minimized, these firms should experience greater performance compared to firms not utilizing IT-enabled knowledge capabilities, firms using unsupportive IT combinations or processes and/or firms not utilizing effective information security.*

Implications and Future Trends

So why might the issues raised in this chapter be important to future research in strategic management and information systems? Firm theory based upon the KBV accepts tacit knowledge as the source of sustainable competitive advantage within the firm (Grant, 1996; Kogut & Zander, 1992). Further, many scholars extend the RBV of the firm to include knowledge as a resource from which competitive advantage may derive (Eisenhardt & Santos, 2002). As proponents of KBV argue that once knowledge is codified, competitive advantage is subsequently unsustainable, what issues will the evolving codification capabilities of IT systems pose to this view? So, the main implications for organizational knowledge and the management of such knowledge rely in the internal structure of the firm and its support mechanisms (Grant, 1996). Further, the organizational capability to transfer and aggregate knowledge is also a key determinant of the organization's ability to grow and sustain competitive performance. Therefore, if we are to assume that organizational growth and performance are moderated by the firm's ability to manage and internally transfer and allocate organizational knowledge, and that knowledge capable of sustaining competitive advantage tends to be tacit by nature, then a firm's effectiveness at acquiring, generating and managing strategic, proprietary and complex competitive tacit knowledge should be positively related to firm growth and performance (Grant, 1996; Kogut & Zander, 1992). Thus, IT systems enabling these activities should theoretically have the potential to contribute to a firm's performance.

KBV holds that while improved knowledge flows may increase organizational performance, once competitive knowledge is codified, it can no longer be a source of sustainable competitive advantage, since replication, transfer and application of the knowledge can facilitate imitation by competitors (Grant, 1996; Kogut & Zander, 1992). Therefore, KBV predicts conflicting outcomes from technically enhanced knowledge capability: (1) A positive relationship with performance from IT-enabled capability in the short- to near-term; but (2) theoretical destruction of a firm's basis of sustaining competitive advantage in the long-term from the codification, replication and transfer of tacit knowledge. However, RBV further confounds this dichotomous theoretical prediction through its central premise that the competitive advantage derived from a resource may be sustainable as long as the resource is valuable, sufficiently protected from external leakage and unwanted outflow, and imperfectly imitable (Barney, 1991).

Regarding our propositions, given this apparent conflict between RBV and KBV, we are unsure of what assumptions to make regarding implications of IT-enabled capability on long-term performance. However, careful consideration could suggest an RBV argument that increased IT-enabled knowledge flow would not necessarily lead to a loss of long-term sustainable competitive advantage, under some conditions. Therefore, we propose that IT-enabled knowledge capability should not, in and of itself, lead to a corresponding decrease in a firm's ability to sustain competitive advantage on that knowledge in the long term. Based on these theoretical arguments from RBV and KBV, we feel that IT-enabled knowledge capabilities will facilitate opportunities for increased firm performance. However, significant further work is needed to develop and model the implications of this for strategic management theory, as well as to test these proposed implications empirically.

Conclusion

This chapter offered an exploration of the evolution of IT-enabled KM capabilities, and a comparison of RBV and KBV suggested implications of these advances on firm performance and sustainable competitive advantage. We argued that IT resources may enable new KM capabilities, which may, in turn, affect firm performance. However, codification and potential leakage of valuable tacit knowledge has the potential to undermine longer-term sustainable competitive advantage. Based on RBV assumptions, and the arguments put forth in this chapter, we feel that this rigid KBV argument is likely not supportable under some circumstances.

Conversely, following an RBV premise, we argue that codified tacit knowledge may be a sustainable source of competitive advantage if knowledge remains valuable, sufficiently rare (protected), imperfectly imitable (uncodifiable components) and non-substitutable. If the codified competitive knowledge is sufficiently protected/deterred from unwanted extra-firm knowledge transfers and leakage, IT-enabled KM may significantly enhance an organization's ability to transfer intra-firm knowledge and, hence, improve competitive advantage and subsequent resulting firm performance.

However, these arguments shouldn't necessarily limit aspects of a KBV perspective, and conversely, may point to KBV's continued relevance by highlighting areas for extension and further refinement. Recent work advocates that the real value of KBV may be in the processes for knowledge sourcing, transferring and integration within and across organizations (Eisenhardt & Santos, 2002). In concurrence with Grant (1996) and Eisenhardt and Santos (2002), theory extension of KBV may require a more comprehensive competency-based view of the firm, which should embrace IT-enabled knowledge capabilities.

Finally, this chapter provided a starting point for examining the relationships among IT-enabled knowledge capability, firm performance and longer-term sustainable competitive advantage. We argue that through the adoption and integration of evolving IT-enabled KM, organizations may have the opportunity to significantly expand their knowledge-based capabilities. Such capability enhancement may serve as cause for reexamination of strategic management theory and its possible extension to handle these implications arising from advances in MIS research and related IT systems.

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Chapter VI

Becoming a Learning Organization in the Software Industry: Is CMM the Silver Bullet?

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Abstract

This chapter examines to what extent the implementation of Software Engineering Institute's Capability Maturity Model (CMM) of software process improvement enables a firm to transform itself into an learning organization (LO). It argues that even though the CMM does lead the software firm forward on the route to learning, it does not go far enough. By recognizing organizational knowledge and organizational learning as the twin pillars of the LO, the author develops a conceptual framework against which the five maturity levels of CMM can be mapped and examined. This allows for an assessment of whether the CMM serves as a silver bullet in achieving the software firm's goal of reaching the visionary state of the LO.

Introduction

Today, across the world, business firms are exposed to increased environmental turbulence and uncertainty. There is rapid change in technology and its usage, and competition in the marketplace has intensified, with customers becoming highly knowledgeable and demanding. With economic realities and priorities shifting constantly, there is now the emergence of a new global economic order in which knowledge or intellectual capital—rather than labor, machine power and capital—constitutes the most critical factor of production as well as a source of competitive advantage (Zack, 1999). Nowhere is this more evident than in the software industry. By its very nature, a firm engaged in developing software applications as its primary product shares all the features of what Alvesson terms as "knowledge-intensive" firms. These firms depict the following characteristics:

1. "Highly qualified individuals doing knowledge-based work, using intellectual and symbolic skills in work;
2. A fairly high degree of autonomy and the downplaying of organizational hierarchy;
3. The use of adaptable, ad hoc organizational forms;
4. The need for extensive communication for coordination and problem-solving;
5. Idiosyncratic client services;
6. Information and power asymmetry (often favoring the professional over the client);
7. Subjective and uncertain quality assessment." (2004, p. 21)

To survive in such a turbulent business environment and achieve global standards with respect to quality, cost and customer expectations, a software firm must not only treat knowledge as its most critical resource but also learn to be highly adaptive in everything it does with the knowledge. It must proactively anticipate emerging trends and directions with regard to the business environment, customers and technology. It must assimilate the knowledge and use it effectively to best meet the customer requirements. Therefore, the software firm must work towards building for itself an all-pervasive learning culture. It must become what is termed as an LO (Senge, 1990).

The CMM, developed by the Software Engineering Institute (SEI) at Carnegie Mellon University, is suggested to be a step in this direction (Levine, 2001). The CMM enables firms to view software development as an engineering discipline and ensure its progression from being an immature, ad-hoc process to a mature, managed process (Paulk, 1998a). Ramanujan and Kesh (2004) note that the last few years have seen a significant investment on the part of software firms to implement the CMM; in most cases, firms also a report a spectacular improvement in financial performance after they have gone through the implementation process. However, the question that remains unanswered is, how sustainable is this improvement effort? That is, does adoption of the CMM enable the software firm into becoming an LO? The aim of this chapter is to investigate this research question. This is important because after the initial fanfare associated with the CMM has died down, the initiative will continue to prove useful only if it enables a software firm to develop an organization-wide learning culture and derive sustainable competitive advantage based on knowledge.

Essential Characteristics of the LO

The idea of an LO is difficult to grasp. This is because not only is it is far from a homogeneous concept but also because the terms “LO” and “organizational learning” are used interchangeably in literature. In tracing the concept of organizations as learning systems, Yeung, Ulrich, Nason and von Glinow (1999) identify eight properties that they suggest constitute the “basics” of LOs: (1) they focus not only on learning but also in meeting organizational goals; (2) they follow a systems logic and engage in out-of-the-box thinking; (3) they build upon but are not limited by individual learning; (4) they follow the learning continuum that stretches from superficial to substantial; (5) they recognize that learning comes from many small failures; (6) they adopt a process approach to learning, understanding that learning often evolves along a predictable set of processes; (7) they give cognizance to both direct experience and vicarious experience as being useful inputs to learning; and (8) they treat learning as being important, not only for “exploiting” existing opportunities but also for “exploring” new opportunities. This suggests that the LO is an ideal or visionary state that firms aspire to reach and one that requires them to engage in transformational, organization-wide, real-time learning.

Senge defines the LO as one where “people continually expand their capacity to create the results they truly desire, where new and expansive patterns are nurtured, where collective aspiration is set free and where people are continually learning how to learn together” (1990, p. 17). Even though this gives an idea of the philosophy behind an LO, Mumford provides a definition that is more practice oriented: “The LO is one that creates an environment where the behaviors and practices involved in continuous development are actively encouraged” (1995, p. 12). In turn, then, OL refers to “a variety of practices and values that enable a company to explore continually new directions and anticipate, or even lead, change in the marketplace and in society at large” (EIU & IBM, 1996, p. 11).

Even though the LO appears to be an ideal or visionary state that a firm endeavours to reach, it is clear that its foundations rest on two specific organizational characteristics: (1) organizational knowledge, and (2) organizational learning. The former denotes the unique resource available to firms to use in order to progress. It can usefully be represented as the *content* aspect of the LO. Similarly, the latter can be referred to as the *process* aspect of the LO; that is, the specific mechanisms that actually allow learning to happen. In the next few paragraphs, I examine these two pillars of the LO and develop a theoretical framework that elaborates on how and when a firm truly becomes one.

Organizational Knowledge

Organizational knowledge is not static. It is created within the firm as a continuous dialog between its constituents; that is, explicit and tacit forms of knowledge available with employees and within organizational artefacts. Though such an exchange arises primarily among individuals, it is the organization that creates the facilitating mechanisms that lead to emergence of dialog. According to Nonaka (1994), the organization manages the four constituent processes of dialog: socialization (creating tacit knowledge through sharing of tacit experience), combination (creating explicit knowledge by combining different explicit knowledge), externalization (conversion of tacit knowledge into explicit knowledge) and internalization (converting explicit knowledge back into tacit knowledge). When all four modes of knowledge sharing occur as a continual shift, organizational knowledge is generated (Nonaka, 1994). Thus, close cooperation among organizational members is necessary for organizational knowledge to develop. This view endorses that organizations are social entities populated by individuals who have an interest and desire to share and learn from each other, and it is through the organizational platform that knowledge and expertise of individuals get converted into economic products and services that have an economic value in the marketplace (Kogut & Zander, 1992). In other words, it is in the organizational space that situated learning occurs between individuals, and which leads to a dynamic evolution of organizational knowledge. This is what is also called the distributed knowledge system (Tsoukas, 1996), where individual knowledge is constantly getting merged, shaped and reshaped as an organizational resource.

The firm's base of explicit knowledge can be expanded in several ways. For example, the firm's current knowledge position may be benchmarked vis-à-vis what are viewed as world-class practices; the firm can also focus on learning as a visible and central element of its strategic intent (by making explicit mention of it in the mission or vision statement); also, the firm can actually go for concrete investments in learning (through adoption of "hard" mechanisms, such as sponsoring employees to training programs, or through "soft" mechanisms, such as devising creative ways and means of employee feedback and suggestions, and by sharing best practices across vertical/horizontal divisions within the firm). Organizational learning does not happen by chance; nor does it happen overnight. Thus, LOs must exhibit "a purposeful learning approach designed to create knowledge and translate it into effective action" (Bohlin & Brenner, 1996, p. 2). By experimenting with collective learning, most firms engage in work practices that generate "ideas with impact." This is possible through continuous improvement, competence acquisition, experimentation and boundary spanning. According to Ulrich, Von Glinow and Jick, "combining the ability to learn by going outside a business' boundaries (i.e., boundary spanning), coupled with a culture focused on internal management processes such as empowerment and teamwork, is most conducive to competitiveness" (1993, p. 64). Firms also generalize ideas that have impact by creating an organizational infrastructure that moves ideas across boundaries. This can be through building up organizational competence (staffing, training and organizational development), management action (appraisal, rewards), governance (management style, policies, organization design, communication, feedback) and work processes (systems, processes, teams).

However, given that the firm competes in a radically shifting and turbulent environment, the knowledge it draws upon is not only inherently indeterminate but also continually emerging (Tsoukas, 1996). This requires that knowledge be viewed as being more than simply tacit or explicit or a sum of the two. Rather, it brings into focus an alternate view of knowledge as "knowing." Cook and Brown (1999) have suggested that if the former (i.e., knowledge) constitutes an "epistemology of possession" (with knowledge being treated as something people possess), the latter (i.e., knowing) calls for an "epistemology of practice" (where the focus is more on people knowing). The authors further suggest that knowledge and knowing are not competing but mutually enabling; together, they constitute a "generative dance" that leads to continuous innovation on the part of the firm. Orlikowski (2002) notes that "knowing in practice" is a social activity that has as its core several important attributes, such as sharing identity, interacting face-to-face, coordinating across time and space, learning by doing and supporting participation. Similarly, using a structuration perspective, Hargadon and Fanelli (2002) suggest that organizational knowledge arises as a recursive outcome of interaction between knowledge as action and knowledge as possibility. In that sense, by its very nature, knowledge is uncertain and never completely revealed.

Organizational Learning

Organizational learning has been defined as the process by which: (1) the organizational knowledge base is developed (Shrivastava, 1983), (2) organizational action is improved through better knowledge and understanding (Fiol & Lyles, 1985),(3) organizational inter-subjective meaning is changed (Cook & Yanow, 1993), or(4) change is effected in individual and shared thought and action (Crossan, Lane & White, 1998). Thus, by its very nature it is suggested to effect both cognitive and behavioral change among organizational members. In a general sense, the cognitive perspective regards organizational learning to be the summation of learning of individuals. It suggests the organization is a cognitive or information processing system (March & Simon, 1958). Any requirement of learning or strategic change is viewed in terms of cognitive maps of managers and employees, as a gap between actual and desired results measured in terms of business performance. Knowledge is taken to be primarily resident in the minds of individuals and from where it can be extracted, packed and stored in repositories for future use or transferred to others (Nidumolu, Subramani & Aldrich, 2001). In other words, the cognitive view takes learning to be primarily an individual activity separate from and, in some sense, even opposed to other activities individuals engage in within organizations (Gherardi, Nicolini & Odella, 1998). However, such an extreme position also seems to suggest that viewing organizational learning exclusively based on the cognitive perspective brings about its own inadequacies.

Though Kolb's (1979) cyclic model of individual learning (concrete experience, reflective observation, abstract conceptualization and active experimentation) has been applied in the organizational setting (Carlsson & Martin, 1976), individual learning forms only a necessary but not a sufficient condition for organizational learning. Huysman (1999) notes that current literature on organizational learning suffers from several biases: (1) it tends to treat the individual as the actor in learning; (2) it considers environmental adaptation as the primary motivator for why organizations learn; (3) it suggests that learning primarily is a planning activity; and (4) it focuses on improvement as the only expected result of learning. While organizational learning necessarily must incorporate these elements, the question that arises is whether fulfilling these conditions will transform the firm into a LO. It is impossible to see cognition occurring at the level of the organization (Cook & Yanow, 1993). Also, most of the time, organizational members cannot agree on common cognitive models to interpret information or take action (Mirvis, 1996). Even if all individuals in the firm engage in learning, does it ensure learning at the organizational level? Again, does planning necessarily ensure optimal learning?

To mitigate these difficulties, researchers have proposed an alternate view of organizational learning based on the social, behavioral cultural and interpretive characteristics of organizations, with the recognition that context is an important parameter in learning (Fiol & Lyles, 1985; Daft & Huber, 1987). Under this perspective, organizational learning occurs when a group of learners (as social beings) engage in joint construction of reality and shared meaning-making, based on social interaction within specific socio-cultural settings (Gherardi et al., 1998; Miner & Mezias, 1996; Nicolini & Mezner, 1995). Thus, learning is a process that is socially constructed and "… focuses on the way people make sense of their experiences at work" (Easterby-Smith & Araujo, 1999, p. 4). When the individual learns, learning gets linked to changes in an individual's interpretation of events and action (Daft & Weick, 1984). Proponents of the social view of learning suggest that individual knowledge is possible only because of the social practices individuals find themselves in (Tsoukas, 1996). Therefore, the social view on learning not only endorses the active participation of individuals in the joint sense of making and learning, but also suggests the extremely important role context plays in this endeavor. The idea of socially constructed knowledge recognizes it as closely following a socio-historical context, made available through the everyday experience of individuals (McAdam & McCreedy, 1999). An ongoing, circular interaction between individually held latent knowledge and the knowledge manifest in the surrounding environment is what enables organizational knowledge to emerge (Hargadon & Fanelli, 2002). Specific mechanisms that may aid in this process of interaction include situational factors, such as the unit's tasks (process or content orientation) and domain of learning (focused or broad) (Becerra-Fernandez & Sabherwal, 2001).

In fact, Lave and Wenger (1991) go a step further. They suggest that not only is learning *situated* in practice, it is in fact hidden from the other regular mechanisms of the organization. Therefore, studying it systematically is extremely difficult (Brown, Collins & Duguid, 1989; Richter, 1998). According to the situated or social learning view, the learning context and relationship of the learners are as important as learning itself. As new members get inducted into the process of collaborative learning and meaning-making, individual schemata, scripts and beliefs get institutionalized into organizational knowledge structures (Cook & Yanow, 1993; Daft & Weick, 1984; Schank & Abelson, 1977; Weick & Bougon, 1986).

At the same time, apart from the individuals engaging in knowledge sharing and exchange, the team/group as well as the whole organization are influenced by organizational knowledge structures. Socialization of individuals in the learning process helps in the dynamic transfer of knowledge from the individual to the organization, as described in Nonaka's knowledge spiral (Nonaka &Takeuchi, 1995). Following this process, the knowledge structure and form of the organization also undergoes changes. It becomes a product of complex relations and interaction between individual beliefs and perceptions and organizational routines (Garud & Rappa, 1994), thus creating an appropriate collective for knowledge sharing across the community of practice (Nonaka & Konno, 1998). Crossan, Lane, and White (1999) suggest that the core processes that constitute organizational learning can be depicted as the 4I (Intuiting, Interpreting, Integrating and Institutionalizing), with intuiting and interpreting focused on the individual level, interpreting and integrating focused on the group level, and integrating and institutionalizing focused on the organizational level. The authors further suggest that a system of feed-forward and feedback learning flows characterizes a back-and-forth flow of knowledge across each of these three levels.

In view of the preceding discussion, I suggest that each of the two pillars of the LO—organizational knowledge and organizational learning—can be usefully looked upon as captured in two distinct states. For organizational knowledge, this state varies from “knowledge” to “knowing.” Similarly, for organizational learning, the states vary from “individual-focused” learning to “organization-focused” learning. By identifying each of these two states of organizational knowledge and organizational learning, I arrive at a 2x2 framework that describes the different stages of a LO. This is depicted in Figure 1. Quadrants 1, 2 and 3 are intermediate stages that the firm finds itself in during its journey towards an LO. In my depiction, a true LO comes into existence in Quadrant 4, where the focus is on knowing over knowledge and organizational learning over individual learning. While it is expected that a firm in Q1 would reach Q4 by either traversing through the intermediate stage of either Q2 or Q3, it is possible that it may reach Q4 directly. This rare event would happen under a visionary change agent within the firm, who pulls up the organization from Q1 directly into Q4, thus by-passing the intermediate stage. Finally, it is important to remember that in Figure 1 the categorizations “knowledge” vs. “knowing” and “individual” vs. “organizational” are merely stylized ways of representing the two orthogonal dimensions. In practice, a firm will describe elements of both knowledge and knowing simultaneously, just as it will depict both individual and organizational learning at the same time. Rather, what I suggest is that in each of the four cells, one of the two forms of organizational knowledge focus will predominate, just as one of the two forms of organizational learning will assume greater importance.

Figure 1. The LO framework

		Organizational Learning	
		Individual-focused	**Organization-focused**
Organizational Knowledge	**Knowing**	*Q3* ***Intermediate stage of an LO***	*Q4* ***The LO***
	Knowledge	*Q1* ***Not a LO***	*Q2* ***Intermediate stage of a LO***

Quadrant 1: This quadrant represents firms that focus on organizational knowledge over organizational knowing. In other words, these firms focus on knowledge possession over knowledge practice. While these firms may also accord importance to tacit knowledge in addition to explicit knowledge, they do so with the idea of possession rather than practice. In effect, these firms seem to adopt a rather static view of how knowledge is acquired, exchanged, utilized and updated. Similarly, these firms tend to lay a greater emphasis on explicit knowledge over tacit knowledge. If they do focus on tacit knowledge, they tend to view it as knowledge that is possessed rather than practiced.

Quadrant 2: This quadrant represents firms that give emphasis to organizational learning over individual learning. Thus, they recognize that organizational learning is more than the sum of learning of individuals. However, by continuing to focus on the idea of knowledge as possession rather than practice, these firms fall short of the target of becoming a true LO.

Quadrant 3: Like Quadrant 2, this quadrant represents firms that are at an intermediate stage in their journey towards becoming an LO. While these firms do focus on knowing—that is, the idea of knowledge as practice rather than as possession—they continue to believe that learning in organizations is simply synonymous with learning efforts of individuals. As such, these organizations miss out on certain important linkages of how individual learning can expand into learning at the organizational level.

Quadrant 4: This quadrant represents firms that not only accord higher emphasis to knowing (i.e., knowledge as practice) over knowledge (i.e., knowledge as possession) but also focus on developing organizational mechanisms, processes and practices that expand individual-level learning into organizational learning. By doing so, these firms transform them into LOs in the true sense of the term.

Having described the essential characteristics of a firm's journey towards becoming an LO based on its understanding of organizational knowledge as well as organizational learning, I now examine to what extent adoption of SEI CMM enables the software firm to achieve this vision of transforming itself into an LO.

The Capability Maturity Model of Software Development

The CMM was developed by SEI to enable software firms to treat the process of software development as an engineering discipline, and develop "reliable and usable software that is delivered on time and within budget … The progression from an immature, unrepeatable software process to a mature, well-managed software process also is described in terms of maturity levels in the model." (Paulk et al., 1993a, pp. 0-1). SEI commenced work on the model in 1986, based on an initial request on the part of the United States (U.S.) federal government, to provide the latter with a method for assessing the capability of its software contractors. The model was first released in 1991. Thereafter, periodic improvements on the model have been continued to be made, based on feedback from organizations that adopted the CMM.

Immature vs. Mature Software Firms

A computer software firm, assessed on the basis of robustness and maturity of the processes used by it to develop software, can be placed along a continuum that progresses from immature to mature. The immature software firm is characterized by an overall ad-hoc, reactive approach to software development. Not only does the firm not have consistently followed processes and procedures for production, testing and quality assurance of software, but whatever processes that may be in place are also thrown to the wind whenever the firm is in the throes of a crisis. In contrast, a mature software organization ushers in a certain consistency and uniformity of approach in the development of software. It possesses established, consistent processes for software development. Planning forms an integral part of the process cycle. Periodic re-evaluation and improvement of currently adopted processes is also institutionalized within the organization. In view of these measures, the mature software tends to produce software that is relatively less prone to defects and errors. To summarize, while immature software firms operate on a reactionary basis, mature software firms display a proactive approach towards managing the processes used to develop software products (Paulk et al., 1993b).

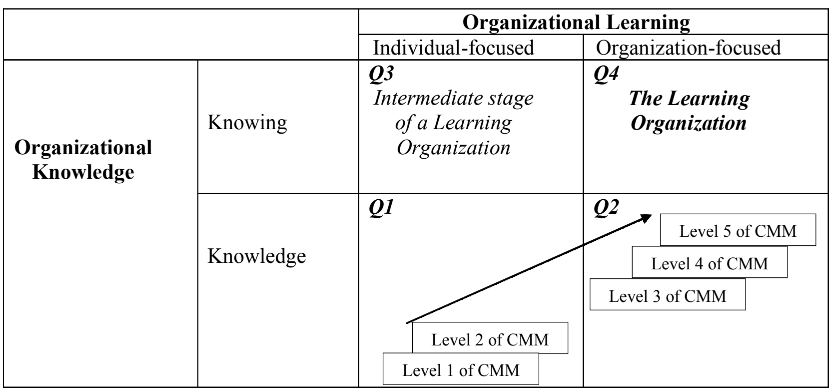
CMM Process Maturity Framework

When it adopts the CMM, the software firm demonstrates a commitment that it intends to move from a software development regime characterized by ad-hoc, immature, reactive processes to one that is disciplined, mature and proactive. The CMM process maturity framework has been conceptualised at five maturity levels (1 to 5), which "define an ordinal scale for measuring the maturity of an organization's software process and for evaluating its software process capability" (Paulk et al., 1993b, p. 7). Each of the five maturity levels of the CMM exhibit certain behavioral attributes. At Level 1, the software process is an amorphous black box that generates a software product when provided with certain specifications; however, it is unable to define or use any process controls whatsoever. This situation improves somewhat in Level 2, where both customer requirements and work products are controlled. At this level, the organizational software process can be visualized as a succession of black boxes that "allows management visibility into the project on defined occasions" (Paulk et al., 1993b, p. 21). Internal structure of the black boxes, the tasks in the project's defined software process, becomes visible in Level 3. This is, therefore, the level at which the software development process is viewed as an organization-wide activity, even though it is broken down into individual projects, and common routines and standards are applied to ensure both process and product quality. Level 4 is a further improvement; processes are instrumented and controlled quantitatively, and ability to predict outcomes and initiate corrective action is high. This culminates in the organization progressing into Level 5, where it initiates a culture of continuous process and product improvement. At this stage, "disciplined change is a way of life" (Paulk et al., 1993b, p. 21). Since each level builds a foundation for the next level, it is preferable for a software firm to progressively go up the maturity hierarchy; skipping levels is counterproductive.

Software Firms and CMM Implementation: A Journey Toward the Learning Organization

Being an organization-wide change initiative based on the principles of total quality management (TQM), adoption of CMM provides an organization with many benefits. Some of the tangible benefits of CMM implementation include "… shorter development cycle, reduced rework, higher development productivity and higher-quality systems" (Duggan, 2004, p.9). The CMM concentrates on developing an organization-wide process architecture that enhances some aspects of both knowledge management and organizational learning through easy acquisition, storage, management and utilization of knowledge on the part of software firms. CMM plays this enabling role mainly through transformation of the processes associated with the software development life cycle, making them less person-specific and based more on robust institutional systems, processes and practices. As a result, the firm necessarily progresses from "ad hoc, chaotic processes to mature, disciplined processes … [which reflect a culture of continuous process and product improvement, and where] disciplined change is a way of life" (Paulk et al., 1993b, pp. 3, 21).

Figure 2. CMM and its overlaps with the LO framework



In attempting to map each level of the CMM (with its associated challenges and benefits) onto the 2x2 LO framework, I arrive at Figure 2, which is a depiction of the extent to which the CMM actually helps a software firm to become an LO.

Under Levels 1 and 2, the firm continues to focus on individual training and learning, with little effort being taken to bring these processes up to the level of the entire organization as a common unit of analysis. Therefore, firms that are either at Level 1 or have progressed to Level 2 cannot be termed as LO at all. For instance, Level 1 firms may produce quality software from time to time, but if this happens, it is due to the personal initiative and heroics of the firm's managers rather than the firm's process architecture. When a firm has progressed to the stage of Level 2, it has initiated a system of managing development of software by imitating and implementing a repeatable set of software development processes. It is expected that at this level the firm has been able to articulate and share most of its explicit knowledge with other organizational members. However, even here the firm is focused too much on the present, with little efforts being made toward learning from the current set of experiences and applying it the future.

Figure 2 also suggests that Levels 3, 4 and 5 emerge as shifting positions within Quadrant 2. In these successive stages of software process maturity, the firm is clearly focused on adopting the entire organization as the unit of analysis. Thus, when it is in Level 3, the firm has already begun to use a set of standard software processes. In addition, under Level 4 the firm begins to practice a quantitative orientation as far as measuring and managing projects are concerned. Further, it has developed the requisite repositories for knowledge storage and retrieval. Finally, at Level 5 the firm is focused on managing and improving the processes on a proactive basis, with the objectives of defect prevention, innovation, knowledge sharing and dissemination of lessons learned across the organization. It is expected that at this stage there will be interplay of tacit knowledge among members, just as there is high emphasis on explicit knowledge exchange.

Even though the CMM and, especially, upper Levels 3, 4 and 5 make a software firm engage in organizational learning, by its very structure it also acts as a constraint in holding back the firm from becoming a true LO. This is because the CMM essentially overemphasizes the structural and process aspects of an organization's journey towards becoming the LO and neglects the equally important people aspects. The framework essentially accords importance to the process and capability aspects of learning at the organizational level. It even emphasizes the skills and behavior aspects of learning at the individual level. In doing all this, however, the CMM continues to follow and emphasize an "epistemology of possession" (Cook & Brown, 1999) with respect to knowledge and learning. It is silent on what further must be done to usher in an organizational culture that values an "epistemology of practice" (Cook & Brown, 1999) with regard to knowledge and learning. In fact, the CMM seems to foster a notion within the firm that whatever gets measured is managed. While this is true with regard to many of the structured, relatively simple aspects of organizational life, it is well known from mainstream theories of the organization that this may not completely represent the totality of the firm's existence. Not only is organizational reality highly complex and ambiguous, but also managers are boundedly rational. This makes managers go for a strategy of satisficing rather than optimizing most of the time. Unfortunately, the CMM does not recognize any scope for ambiguity within its processes.

In his study of what he terms as "high maturity organizations," Paulk (1998b) finds that these firms address several organizational issues that go beyond the scope of the CMM. These relate to developing a culture of openness and communication, commitment to quality, customer responsiveness and other "peopleware" issues. In contrast, the CMM seems to overemphasize what may be termed as the "hard" aspects of management and, in doing so, neglects its "soft" aspects. For example, process and capability mainly denote the structural or harder constituents of learning at the organizational level, whereas leadership and climate denote the visionary, style and cultural or softer constituents. Similarly, at the individual level skills comprise the harder constituent while behaviors and, to a greater extent, values constitute the softer components. The CMM implicitly assumes that the softer prerequisites are given or already existing within the firm. For example, top management vision, foresight and commitment are taken for granted, assumed as being exhibited by the decision to implement the model. Similarly, individual values may be said to exist, in the desire to use the model, achieve error-free software programs and continuous improvement, and thus ensure teamwork, transferability and sharing of knowledge.

According to Elkjaer (2001), a problem that plagued the initial efforts of organization towards becoming an LO related to the ways in which learning was understood. It was supposed that if individual learning was taken care of, organizational learning was bound to result. It is only later that specific concern, such as the assimilation of individual learning into organizational learning, began to be examined. In her study, Levine (2001) finds that learning and a program of adoption of technical change (such as the CMM implementation) mutually reinforce each other. Yet, it can be said that though adoption of CMM takes the software firm forward towards becoming the LO, it does not go far enough. Mathiassen and Pourkomeylian (2003) find that to become effective at managing knowledge, a software process improvement (SPI) initiative (such as the CMM) must strike a balance between personalized and codified aspects. This is because the organization in which information systems development occurs is essentially a socio-technical system in which technical processes combine with social ones and involve stakeholders at multiple levels of the organizational hierarchy (Robey, Welke & Turk, 2001; Sawyer & Guinan, 1998). Therefore, not only does the SPI need to be flexible and amenable to change over time, but it must also maintain a tension between dialectical opposites—codified vs. tacit, individual vs. the organization, informal vs. formal. Unless it is able to do this, the knowledge management efforts engaged in through the SPI will achieve adequate results but certainly not transform the firm into an LO. This is an area where the CMM leaves much to be desired.

Ravichandran and Rai believe that "… many software process improvement frameworks, including the CMM, do not pay adequate attention to the organizational factors that enable or constrain process improvements" (2000, p. 401). In fact, even with respect to knowledge management, which is only a part of the organization's overall journey towards becoming an LO, the CMM has further to go (Ramanujan & Kesh, 2004). Though adoption of the CMM does position the software firm on the road to transforming itself into an LO, to ensure sustainability of collective learning within the firm, its leadership must continually demonstrate in no uncertain terms the commitment to organizational learning. This will need to be reinforced through creation of an organizational climate that fosters innovative behavior on the part of employees and adoption of the essential

Table 1. SEI-CMM process maturity framework (adapted from Paulk et al., 1993a, 1993b)

Level	Name	Process Qualifier	Behavioral Characterization
1	Initial	Ad hoc	• Unstable internal environment for software development • Planned procedures abandoned during crisis • Quality of output depends on maturity and resilience levels of staff • Schedules, budget, functionality and quality remain unpredictable
2	Repeatable	Disciplined	• Policies established for managing the processes • Repetition of successful practices developed earlier • Basic software management controls exist • Software project standards are defined and adhered to • Software costs, schedules and functionality are tracked and monitored
3	Defined	Standard, consistent	• Standard software engineering/management processes documented and integrated • Adequate training programs imparted to staff to use software engineering concepts • Individual projects use baseline, standard software processes already available with the organization
4	Managed	Predictable	• Productivity and quality standards measured for all important software activities across projects • Organization-wide process database used to collect, store and analyze information on projects • Quantitative measurement standards available to evaluate projects' software processes and products • Meaningful variation in process performance can be distinguished from random variation
5	Optimizing	Continuously improving	• Focus on organization-wide continuous process improvement • Means available for identifying and strengthening process weaknesses proactively • Software engineering innovations identified and adopted across the organization

"epistemology of practice" (Cook & Brown, 1999) based on adoption of an organization-wide enabling value system (trust, spirit of sharing and respect for the individual).

Conclusion

In this chapter, my main aim has been to synthesize the growing body of literature on knowledge and learning with the primarily practitioner-driven framework of software quality assurance and process improvement—that is, the CMM. I have done this to identify whether the CMM process framework indeed acts as a silver bullet in the software firm's quest for becoming an LO. My analysis reveals that even though adoption of the CMM does take the software firm forward on the route to learning, it does not go far enough. Being a quality assurance framework, the CMM mainly concentrates on strengthening the structural or "hard" issues of ensuring collective learning based on predominantly codifiable or explicit knowledge. Therefore, it falls far short of concomitant changes in behavior, beliefs, values and culture that are required of employees if the firm is to truly transform itself into the LO. Future research efforts could concentrate on exploring how to build these "softer" concepts of the LO into the CMM.

This discussion on explaining to what extent the CMM transforms a software firm into an LO has several limitations. I have restricted the scope of the discussion to include only the CMM. It must be recognized that there are other associated/variant models also available with the SEI and adopted by software firms—for example, the People CMM, CMMI, PSP and IDEAL. However, these are outside the scope of the present discussion. To conclude, it is fair to suggest that even though the CMM has become the most popular TQM framework currently being adopted across the software industry, it has certain inherent limitations that do not take the software firm adopting the CMM to go far enough on the road to becoming an LO. The quest for becoming an LO, thus, continues to remain a journey along an arduous path, and one that the software organization must traverse with a great deal of foresight, experimentation and humility.

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Chapter VII

ERP as an Integration Strategy: Issues, Challenges, Benefits, and Risks

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Abstract

Integration has been the dominant technical strategy of Information Technology (IT). Computers were introduced for business use and have evolved through multiple stages, including integration of subroutines, modules, programs and applications. Major developments include database, object-oriented programming and communications technologies (especially the Web and Internet). Although integration continues as a technical strategy, IT integration has become part of the overall business strategy due to considerable organizational dependence on IT. The complexity of IT advances necessitated viewing and managing major IT components differently, which have become known as infrastructures. Since the late 1980s, implementation of enterprise-wide systems has been the primary IT business strategy, although it entails great cost, risks and disruption of operation. This chapter describes the evolution of IT integration strategies and examines enterprise resource planning (ERP) as the most popular IT business strategy. The major theme is IT integration, and we examine the question, "Is IT integration desirable?"

Introduction

Michael Porter (1987) described corporate level strategy as the overall plan for a diversified company. Clearly, IS is a significant part of every modern enterprise and, hence, critical to a successful business strategy. Alignment of IS with the corporation is thought to be critical to firms who seek a competitive advantage (Brown & Magill, 1994). As other chapters illustrate, several specific IS strategies exist. This chapter describes integration as the overall and, arguably the most important, IS strategy. Integration touches every aspect of IS, from programming to monolithic enterprise systems. Hamilton (1999) advocates that integration is the guiding principle for all IS pursuits. We use ERP systems as a lens to describe the integration phenomenon and suggest that ERP systems are one strategy organizations exploit to achieve IS integration. This seems appropriate because, in the IS and management literature, ERP systems have often been cited as a vehicle for organizational change and Business Process Reengineering.

This chapter is organized into seven sections. First is the introduction. Then we briefly describe the background and history of integration and ERP. The focus is on understanding the importance of ERP, its evolution and its benefits. The next discussion describes ERP in terms of whether it is the right choice for IT strategy. Then, we present a different perspective on ERP, where the downsides of ERP are examined. Our intention is not to deny the value of ERP, but to challenge the rationale behind the decision to choose ERP. Following is where we revisit some of the fundamental aspects in the concept of "integration." We argue that integration is vital to any IT strategy. Then, we discuss the practical issues involved in acquiring IT integration. We look at past, present and future approaches. Finally, we offer some thoughts on the future direction of IT strategy: "What is next after ERP?"

Background and History

Integration is seemingly a universal idea found in numerous disciplines, including the sciences, humanities, engineering and business (Anderson, 1991; Davenport, 1998; Hill, Brinck, Patterson, Rohall, & Wilner, 1993; Pelkmans, 1980; Shanley, Crossan, & Hodgson, 1999). This chapter is concerned with IT integration (Alsene, 1994; Davenport, 2000; Ein-Dor & Segev, 1982; Goodhue, Wybo, & Kirsch, 1992; Kalakota & Whinston, 1993; Markus, 2001; McLeod & Bender, 1982; ; Senn, 1978). References to IT integration are frequently found in the literature, although without explanation (Waring & Wainwright, 2000). Likewise, theories of IT integration are woefully missing.

Integration Concept

An ERP system is virtually a synonym for integration, since ERPs seek to achieve integration of core business processes and operations by way of IS. We focus on integration because it has been the dominant IT theme for organizations over the past 10 years and has been a major objective of IS organizations for decades (Alsene, 1994; Veth, 1998; Cadarette & Durward, 2002; Singletary, 2003). The pursuit of integration seems natural and entails great rewards, although the reality of the risks, difficulties and challenges are becoming increasingly evident (Davenport, 2000, 1998; Hamilton, 1999; Irani, Themistocleous, & Love, 2003; Jeusfeld & de Moor, 2001; Prencipe, Davies & Hobday, 2003). Cadarette and Durward (2000) remind us that full integration is not easy to achieve:

"… from the dawn of the computing age, integrated automation has been the Holy Grail of computing. And like the Holy Grail, achieving full integrated automation remains elusive, despite huge investments in a wide array of technologies that promise integration …"

Others seem to agree (Goodhue et al., 1992; Hamilton, 1999; Waring & Wainwright, 2000).

The integration of independent systems and data began with projects involving a few applications (Hale, Haseman, & Groom, 1989; Tapscott & Caston, 1993). Later in the 1980s, the introduction of the packaged enterprise computing approach, referred to as ERP, marked a new era that gained considerable momentum in the mid 1990s with the impending Y2K.

In some cases, integration has been viewed as a barrier to automation of business process (Irani, Themistocleous & Love, 2003). The scope of the integration efforts has broadened to encompass enterprise-wide initiatives, such as ERP, enterprise data warehouses (Davenport, 2000) and inter-organizational systems (Konsynski, 1993; Kumar & van Dissel, 1996). A variety of approaches to achieve enterprise integration have emerged, including ERP, homegrown interfaces, enterprise application integration (EAI), middleware, componentware, XML, Web services and service-oriented architectures.

IS Integration Domains

The notion of integration is multi-faceted and vague, and appears to vary from situation to situation even within the same domain. Perhaps, Waring and Wainwright (2000, p. 131) stated the bewilderment best.

"Many diverse opinions exist within communities researching and practicing forms of integration of IS. It is a concept which may be construed to mean 'all things to all people' and yet, perhaps, it is too easily accepted at face value without an adequate comprehension of its meaning …"

We agree that the meaning has "metamorphosed" over time. Some of the ambiguity seems traceable to the trend of equating integration and interfacing (Waring & Wainwright, 2000; Singletary & Watson, 2001).

Table 1. Integration prospectives

Integration View	Description and Discussion	Author
Technical	Allows exchanging information among users regardless of location. Deals with issues like computers, networks, software and the like.	Mudie & Shafer, 1985
Systems	There are several views of system of integration. Most are concerned with coordination and communication among subsystems and component parts. Below (1987, p. 17) says, "… integration is a result or an effect of correct commonality." Several authors delineate between interfaces and integration. Much of the literature in this area are concerned with manufacturing rather than with IS, although the IS has been greatly affected by the view of systems	Shunk & Filley, 1986 Mize, 1987 Das ,1992
Organizational	Organizational integration refers to the ways a business is organized and operated in term of management. This view also includes a social element, since people are part of the formula.	Broaden, 1991 O'Sullivan, 1992 Voss, 1989 Platts, 1995
Strategic	This entails a resource-oriented perspective and is often concerned with planning and use of products and services to help the organization achieve its mission or objectives.	Das, 1992 O'Sullivan, 1990 Platts, 1995

Source: Waring & Wainwright, 2000

Several views of IS-related integration are shown in Table 1. Additionally, Voss (1989) proposed five types of integration, Jeusfeld and de Moor (2001) discuss concept integration, and Hamilton views integration at the portfolio level. Much of the thinking behind modern-day views of integration appear evolved from complex products and systems (CoPS) (Prencipe et al., 2003).

ERP Investments

In the beginning, IT applications were developed to serve functional areas. Each worked independently from one another. As a result, coordinating and integrating many different tasks even within organizations was difficult. Europcar, the largest European-based car rental agency, experienced this problem firsthand when it tried to integrate 55 mainframe and minicomputer systems into a single enterprise system. Europcar's integration initiative went beyond consolidating the various pieces of hardware and software. The company also integrated the business processes, customer preferences, relevant data, as well as established a uniform set of business practices and standards. Though the project was a challenging and risky endeavor, the result transformed a company that was geographically dispersed and culturally diverse into a multi-country, team-based organization supported by one integrated enterprise IT (Turban, Rainer, & Potter, 2005).

Perhaps the story such as Europcar is the reason behind billions of dollars of investment in ERP undertaken by many companies. More than 35,000 firms worldwide spent around $20 billion on ERP in 2000. The ERP business was expected to grow to $70 billion in 2003. ERP applications in recent years have been one of the largest- and fastest-growing areas in IT business solutions.

Although organizations, collectively, spend billions of dollars to integrate their IT through applications such as ERP for competitive advantage, the return of investment remains uncertain (Singletary, 2003). While most studies have investigated success factors, few examine the basic assumptions about the characteristics, benefits and downsides of integration that influence decisions and actions. For many practical situations, "perception is reality." One of the motivations in this chapter is to address this knowledge gap by looking at past, present and future developments of enterprise IT and how they may shape the focus of IT strategy. Although we argue that ERP systems are a key component to the IT strategy of many organizations, it is important to look at the challenges and problems that accompany these monolithic systems. Thus, some issues and problems are examined that have plagued numerous projects. Based on our understanding of these issues and problems, we describe possible future directions of IT strategy.

Evolution of ERP

ERP has its root in operation in supply chain management. Because of the interdependence among supply chain activities, production scheduling is related to inventory management and purchasing plans. In the 1960s, material requirements planning (MRP) was introduced to integrate production, purchasing and inventory management of interrelated parts. Computerized MRP software greatly enhanced inventory control and streamlined supply chain activities. However, they had two major limitations, because they lacked financial and labor information. As a result, manufacturing resource planning (MRP II) was introduced to add labor requirements and financial planning to MRP (Sheikh, 2002). As more integration of functional information systems was sought, the concept of ERP emerged. The basic goal of ERP is to integrate transaction processing and other routine activities of all functional areas in the whole enterprise.

Since ERP is originally evolved from the MRP II system, its initial adoption has been to support the integration of the planning, management and use of all resources in the manufacturing sector. However, the potential of ERP was quickly realized by other sectors. With further development and enhancement, ERP has been transformed into an applications and software architecture that facilitates the flow of information between operations, finance, accounting, marketing and human resources functions within a company and, as such, is an enterprise-wide IS (Radovilsky, 2002). Relying on a standardized centralized database, ERP system components can interact with an integrated set of commonly designed applications, consolidating all business operations into a uniform system environment (Radovilsky, 2002). With the convergence of computing and communication, ERP is pushed into a new horizon, where it has to manage and control all major processes in real time and from many different, dispersed locations. It connects back-end operations to front-end operations. In sum, an ERP's major objective is to integrate all departments and functional information flows across a company onto a single-enterprise IT (Turban, Rainer & Potter, 2005).

Despite tremendous publicity, the first stage of ERP has been plagued by many trials and errors. Implementation of ERP often ran over the projected budget due to delayed schedule and unanticipated complexity. Companies generally recognized the financial commitment required for an ERP implementation, but often they could not sustain the continuous resources for the project. As a result, the enormity of an ERP project was regularly underestimated (Radovilsky, 2002). Other limitations also contributed to ERP failures. For instance, because the use of ERP systems requires the redesign of business processes, users may not welcome it and might resist ERP implementations. The selection of inappropriate software causes misalignment among the existing architecture and applications and the new ones. Lack of uniform standards and procedures between back-end and front-end application causes breakdowns. Companies' expectations of ERP often exceed what it can deliver. Indeed, an ERP system is not all-powerful. It alone cannot transform a company.

Recognizing the limitations of the first-stage ERP software, major vendors, such as SAP, Oracle, Invensys, PeopleSoft and J.D. Edwards, relentlessly work on improving their systems. Enhancements are included to incorporate advanced technology for better integration. Three major enhancements are identified in the development of ERP. The first improvement focuses on the enhancement of existing tools. For instance, advanced optimization solutions are added to modules in forecasting, materials requirements planning, short-term scheduling, inventory management, finance, marketing, human resources and so forth. The second improvement brings Web capabilities to ERP systems. For instance, Web services and Web portals facilitate the integration between the ERP systems and Web applications. The final improvement extends ERP to reach e-commerce supply chain management. The integration of ERP with business-to-business (B2B) e-commerce supply chain management solutions, for instance, includes seller-oriented marketplaces, buyer-oriented exchanges (e-procurement), e-portals, exchanges and others (Radovilsky, 2002).

Is ERP the Right IT Strategy Choice?

The trend today is that many organizations are changing from function-oriented businesses to process-driven entities. ERP systems enable this to happen, not only at the data consolidation level but also the IS and applications levels.

The Importance of ERP

The growth of ERP's importance is a direct result of business organizations' attitude towards how their IS are to be developed and integrated to gain competitive advantages. Merely automating systems is no longer sufficient, because the key to efficiency and effectiveness is to build integrated system solutions to serve an entire enterprise. Various functions of an organization have to be linked together so that whenever a change in an external "pull" takes place, the company is able to adjust to it immediately and effectively. This proactive adaptability of an enterprise around redefined business objectives is called enterprise-wide integration (Radovilsky, 2002).

Data integration has become a primary activity for many organizations (Pearson, 1999). Integration is touted as the most important and, hence, the most desirable, characteristic of ERPs. Integrated Enterprise Systems (IES) have proliferated during the past decade. By 1997, worldwide revenues from ERP were $14.4 billion (Thibodeau, 1998). SAP, AG (a German-based ERP vendor) claims to currently have 30,000 worldwide ERP installations (wwwext03.sap.com/usa 2002). This is a 58% increase over the 19,000 SAP installations reported in 1997. Enterprise systems are massive, complex and costly. “Organizations spend at least 40% of their IT budget for integration” (Puschmann & Alt, 2001, p. 1). The enormous cost and explosive growth of integrated IT applications clearly indicate the importance of IT integration in today’s global business environment.

How does ERP rise up to become such a strategic resource to today’s business organizations? What are the benefits and shortfalls of ERP emerged from the literature? We will explore these questions by looking at the evolution of ERP and examining the benefits and questions about these benefits.

Benefits of ERP

Many IT researchers and firms believe that integration through ERP yields positive benefits. The virtues and advantages of applications integrations for enterprise systems, especially ERPs, have been widely reported in the literature (Boudreau & Robey, 1999; Davenport, 1998; Markus, 2001; Markus & Tanis, 1999; Strong, Volkoff, & Elmes, 2001). Additionally, the practitioner press has led a crusade of sorts advocating the merits of enterprise-wide integration of IT (Waring & Wainwright, 2000).

In the early days of non-integrated systems, ERP provided companies two major capabilities: a unified enterprise view of the business common to all functions and departments (integration); and an enterprise database for all business data management and automation (Radovilsky, 2002). Other advantages noted in the literature and observed by practitioners include: easier access to reliable information; elimination of redundant data and operations; reduction of inventory and production cycle times; and easier adaptability in a changing business environment. All of these provide business organizations with many potential bottom-line benefits, such as lower cost through efficiency and effective use of resources, greater reliability in products and services, and competitive advantage in the marketplace.

Although we realize many benefits of ERP, next we shift our focus to the downsides of ERP. Indeed, even now after many billions of dollars were spent on ERP, there is still not an effective way to measure integration so we can assess costs of integration (personnel, equipment, software, etc.). Only with a good assessment can we relate benefits to costs. It is estimated that firms spend as much as 40% of their total IT budget on integration. Many firms have annual IT budgets exceeding $50 million per year; if the 40% rule is accurate, these firms will spend some $20 million on integration based on *faith* that integration is worth the expenditure. The counter argument is that firms do know that integration is paying off, since profit-earning organizations are not dumb. However, consider the following situation. Two separate systems are combined and the result is lower overall costs. One can make a strong case that this action constituted application integration and resulted in lower cost. But, is the combination of two applications really integration, or merely the elimination of duplication? What other alternatives that would have had the same benefits could have been pursued?

We argue that IT decision makers are proceeding with integration projects based on presumed cause and effect with little or no evidence to substantiate their belief. We hope our subsequent discussion of the downsides and emerging trends in ERP will provide the means for IT professionals to make informed and reasoned integration decisions based on confirmatory evidence rather than on mere faith. Our attempt here is not to deny ERP's value, because we realize many of its benefits. However, what we want to raise is the merit, the rationale as well as the potential wrong assumptions in making the decision to acquire and implement ERP as a part of IT strategy.

ERP Implementations: Problems and Issues

Increasingly, a few IS researchers have begun to question assumptions about the benefits of ERP and the degree of integrating different systems with ERP. The issue is whether it is desirable or practical (Hecht, 1997; Sasovova, Heng & Newman, 2001). As Filipczak put it, the paradox is that, "The value of [an ERP system] is that it is totally integrated; and the downside of [an ERP system] is that it is totally integrated" (Filipczak 1997, p. 49). While most practitioners and academic researchers seem to value integration, the practicality of 100% ERP is questionable.

The notion that a company can and ought to have an expert (or group of experts) create for it a single, completely integrated supersystem—an "MIS"—to help it govern every aspect of its activity is absurd. (Dearden, 1972, cited in Markus & Tanis, 1999, p. 173)

Others also echo Dearden's sentiment that the demands imposed by integration might be too great in some circumstances (Goodhue et al., 1992; Sasovova et al., 2001). Prompting these concerns are issues related to complexity, turbulent business environments, short application lifecycles and rapid technological changes.

In this section, we focus on eight major integration concerns drawn from current literature relevant to ERP[1]. These concerns are briefly discussed below.

- **Loss of Control Issues :** "Does … dependence [on vendors] have negative effects on organizations?" (Markus & Tanis, 1999, p. 194). If an organization creates a system, then their IT staff understands the system and is able to perform maintenance and add functionality. This situation changes when software packages are purchased from a vendor. Typically, from a third party, consultants are hired to help with configuration, training and implementations. Even when the organization's staff is deeply involved with learning the purchased software package, the organization must still rely on the vendor for new functionality and routine maintenance.

- **Design Issues:** "Rather than designing a system to meet the organization's idiosyncratic ways of working, enterprise systems adopters often adjust the organization's ways of working to fit the package (because modifying packages has numerous negative consequences)" (Markus & Tanis, 1999, p. 176). So, the advantages traditionally associated with requirements analysis are eliminated.

  Enterprise systems are typically designed as tightly coupled. This means the components (applications) were designed to work together and to use a common database. On the surface, this sounds good. The problem is that it reduces flexibility and can have unintended negative side effects (Perrow, 1972). For instance, "The tight integration of all processes in an EWS [enterprise-wide systems] package reminds one of the butterfly effect as discussed in relation to Chaos theory" (Sor, 1999)[2].
- **Costs and Risks:** Acquiring and implementing ERP systems can be both costly and risky. Risks include picking the wrong vendor, disruption to operations, huge financial investments and at the extreme, even bankruptcy (Boston Consulting Group, 2003). Ross (1999) found that ERP implementations could be very disruptive and have adverse effects on employees, including management. "… There is general consensus that business process change adds considerably to the expense and risk of an enterprise systems implementation. The principal reason is the difficulty of managing large-scale human and organizational change" (Markus & Tanis, 1999, p. 177).
- **Organization Fit:** Integration may not be appropriate for some organizational structures and business models (Davenport, 1998). Slater (1999) reported that Dell discontinued the implementation of an ERP system because of a lack of fit between the software package and Dell's management style. The volatile business environment requires agile companies that can constantly adapt. However, organizations that change their organizational structures too often may find ERPs unsuitable (Bancroft, Seip, & Sprengel, 1997).
- **Cost and Competitive Advantage:** It is widely known that ERP systems are costly to acquire and implement. For example, Bailey (1999) reported that Allied Waste discontinued a $130 million computer system because it was considered too expensive and complicated to operate. Fear of losing competitive advantages has been given as a reason by some firms for not implementing enterprise software (Davenport, 1998).
- **Complexity:** Enterprise systems are challenging both technically and managerially. ERP systems can contain more than 10,000 tables and 1,000-plus business processes. "Enterprise systems projects are managerially challenging, since they may involve parties from many different organizations and cut across the political structures of the organization" (Markus & Tanis, 1999, p. 182).
- **Disintegration:** The focus of enterprise systems has been on integration. However, disintegration can be equally important and even more complex for multidivisional organizations. Reasons for disintegration include divestures and outsourcing (Sasovova et al., 2001). Davenport (2000) believes it is unlikely that firms will devote much attention to disintegration issues.

- **Best Practices:** In theory, best practices represent the best way to conduct business. However, the benefits derived depend on how the best practices are operationalized. According to Sasovova et al. (2001, p. 145), "The major constraint to the successful transfer of best practices is the nature of the innovation." Others, including Boudreau and Robey (1999), have argued that technology does not guarantee success. Even if best practices did consistently improve operations, this would level the playing field, thereby likely causing negative competitive advantage problems.

Understanding Integration as an IT Strategy

In the age of globalization, some people believe that the way companies traditionally organize and conduct their business is ineffective. With today's rapidly changing environment, the traditional models of hierarchy, standardized procedures, functional divisions and performance measurement are viewed to be outdated. More flexible and adaptive capabilities are needed to respond to the dynamic and turbulent changes in the market. Hence, it is not surprising to see a wave of new and even radical strategy being pushed forward to achieve organizational transformation, including recommendations such as process redesign (Davenport, 1993; Hammer & Champy, 1993), corporate renewal (Bartlett & Ghoshal, 1992), business rejuvenation (Stopford & Baden-Fuller, 1994), strategic stretch and leverage (Hamel & Prahalad, 1994) and organizational transformation (Gouillart & Kelly, 1995). All of these concepts have been articulated and applied at the organizational level, and some have been applied in the formulation of IT strategy.

The Changing IT Strategy

In this section, we focus on IT strategy. Similar to the business strategy, the objective of IT strategy is to develop an IT architecture that is dynamic, flexible and adaptable to changes. According to Cross' (1997) observation, the evolution of IT strategy has gone through three stages. The first stage of IT strategy during the 1960s and 1970s focused mainly on the development and implementation of systems that could help organizations achieve efficiency and cost saving. The second stage occurred in the 1980s and was concerned with managing IT as a strategic resource. The primary goal was to have IT function aligned with the business strategy and to gain competitive advantages. In the 1990s, because of tremendous IT cost and doubts about IT, the IT strategy was guided by principles of cost reduction and tangible benefits. Outsourcing, decentralizing, downsizing were some examples of such a strategy. Now, we are entering the 21st century. The business environment is driven by fast network connection, commercialization of the Web and growth of globalization. What would the IT strategy be like?

Based on our observation of the today's trends in IT, we posit that the key to the IT strategy in the 21st century is "integration," which is the focus of this section. As described earlier, integration efforts such as ERP have failed too often. For many, ERP may not always be desirable or deemed practical for a number of reasons mentioned above. However, we argue that IT integration remains important and necessary for the transformation of business organizations. In this section, we will revisit and discuss the fundamental concept of integration. Our coverage will explore some of the key aspects of integration. A deeper understanding of integration will provide a platform that may enable us to intelligently evaluate various integration strategies and arrive at prudent decisions.

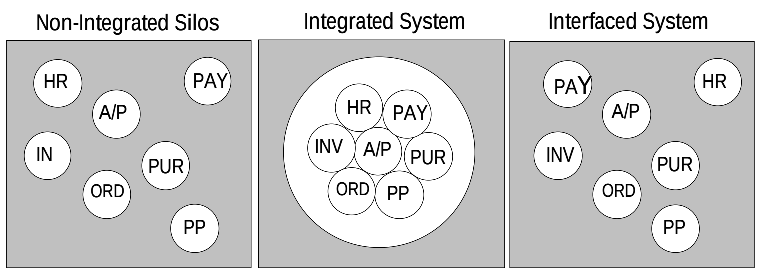
Fundamentals of IT Integration[3]

The concept of integration is not new, as Cadarette and Durward (2000[4]) described: "… From the dawn of the computing age, integrated automation has been the Holy Grail of computing ..." A review of the topic of integration in IS research literature shows that the pursuit of IT-enabled integration dates back to the dawn of the computer age—the idea for enterprise-wide integration was considered as early as the 1950s and 1960s (Alsene, 1994).

Not long ago, the IT profession was concerned with integrating islands of information. Then the focus shifted to the integration of applications to form enterprise systems. During the last 5 decades, experts have sought to integrate the various functions of the enterprise using computers (Diebold, 1952). The initial concept was to create a single, totally integrated system for an enterprise (Blumenthal, 1969; Gordon, 1960). The next major school of thought sought to achieve enterprise integration by having all programs "feed" off a single, centralized database for the entire organization (Diebold, 1952). Integration efforts have evolved during the last half century, from interfacing modules of a computer program to the electronic coupling of different organizations with one another (known as B2B). Successive generations of integration technologies have become increasingly complex as the scope of integration has continuously expanded.

Historically, the research emphasis in IS and computer science domains mirrors a similar pattern, moving from "small-scope" to "large-scope" integration topics. The emergence

Figure 1. Integration and interfacing (Source: Singletary & Watson, 2001)



of enterprise systems, in particular, has prompted calls for intensive IS research in this area. As Markus and Tanis (1999) comment, "Integrated enterprise systems deserve serious research because of their great potential for financial, technical, managerial, human and strategic benefits, costs and risks" (p. 173). Likewise, Waring and Wainwright (2000) proclaim there is an urgent need for concept and research on integration of systems.

Intuitively, we know integration is how well "things" fit together or relate to one another (Prencipe et al., 2003; Singletary et al., 2004; Waring & Wainwright, 2000). Webster's New World Dictionary defines integrate as, "*to make whole or complete by adding or bringing together parts*." What are the IS-related things we desire to integrate? We know that integration is defined in terms of parts and the relationship among parts. What is a relation? The Merriam Webster Dictionary says it is, "*an aspect or quality (as resemblance) that connects two or more things or parts as being or belonging or working together or as being of the same kind ...*" We can, therefore, deduce that, in general, integration is the relationship among artifacts.

Fundamentally, integration means working together, whether it is technology, organizational units, personnel, industries and so forth. As shown in research, integration is an intrinsic and purposeful part of IT strategy as well as organizational strategy that relies on IT. Integration has been researched at different levels: continent-wide (European Common Market), industries (e.g., electronics), global firms, divisions of a national firm, business processes and technologies. In MIS, infrastructures, critical success factors and alignment of IT with organizational objectives are popular research topics.

We can begin by attempting to classify the relationship among IT artifacts into three distinct groups: No Integration, Integration and Interfaces. Figure 1 illustrates these three possibilities. The classic non-integrated example uses silos and islands as metaphors. Originally, systems were like silos, with each totally independent of and isolated from the other. The same was often true for organizational units (unrelated divisions), data files and processes. Thus, much duplication was observed. Then, someone got the bright idea of sharing. So, interfaces were created among applications to share data. Software function libraries were created to eliminate duplicate code and to reuse code. The creation of the relational database provided a means to combine previously separate files into a common database for use by all applications. The above-enumerated steps, along with many others, became known as integration.

Does integration have one or several meanings? The answer is yes, and it is context and audience dependent (see Table 1). This leads to the idea of integration types. Even a cursory review of the literature reveals several types, including data, process, applications and organizational. Our initial impression is that all IT-related integration is data-centric. If we accept this idea, then what is data integration? C.J. Date, one database authority, says that integration is the "… unification of otherwise distinct data files, with any redundancy … wholly or partially removed" (Date, 1995, p. 4). Others define data integration as "… the use of common field definitions and codes across different parts of the organization" (Goodhue et al., 1992, p. 294). It seems plausible to apply Date's definition with little modification to describe an integrated enterprise system (IES). Thus, we might define IES as "the unification of otherwise distinct application systems, data, organizational units and other components, which interact with one another to appear seamless to the end-user." Even if this were an acceptable IES definition, it is of minimal value for integration assessment.

Approaches to Achieve IT Integration

Many companies recognized the importance for IT integration, since IT integration could support business across functional lines and global operation. Integration helps remove organizational barriers and reduces duplication of effort. Yet, what is the best approach to acquire and achieve IT integration? Based on the software acquisition strategy, we observed three general approaches. In the past, the most common approach is to buy commercial, off-the-shelf functional applications from major ERP vendors, such as Oracle, PeopleSoft, SAP and so forth. This requires substantial investment in resources and expertise, as well as infrastructure. This approach is often limited to larger organizations.

In recent years, a new approach that has gained popularity is the arrangement of leasing the enterprise software applications, such as ERP, from application service providers (ASPs) to their clients. This is an attractive option for small- and medium-size companies, because they don't need to acquire expertise or invest in hardware and software. The setup time can be quick; however, there is a greater risk because of the clients' total dependency on the ASPs. The third option is to develop custom ERP applications to suit particular needs. This option is increasingly feasible because many development tools are available that support custom-made applications in a specialized or functional area. For instance, a university student registration, hospital pharmacy management system and so forth can be packaged and implemented to suit particular needs of a client.

Future Trends

IT continues to evolve, especially at the enterprise level. In this section, we examine the current status of ERPs and describe some the trends for enterprise integration.

Is the End of ERP Near?

Few disagree on the need for IT integration; some have begun to wonder about the best way to achieve IT integration and eventually build an integrated IT architecture. For instance, despite a number of success cases, the implementation of ERP is a challenging and risky endeavor, as pointed out by critics. On the financial side, some believe that enterprise IT is inappropriate and can potentially bankrupt a company due to its tremendous costs. Among the high-profile cases of ERP failures are: An ERP integration problem at Hershey led to a significant drop of earnings in 1999; the bugs in ERP at

Whirlpool Corp. caused major delays in shipment in 1999; and the failure of ERP led to FoxMeyer filing for bankruptcy in 1996 (Turban et al., 2005). On the business side, companies are growing tired of expensive licensing and hardware investments, never-ending software deployment cycles, random outages and regulatory-compliance horrors (Knorr, 2004). On the technical side, some believe that enterprise IT is drowning in its own complexity. In sum, although there are various options to provide the means to acquire technology necessary for integration, the reality of combining existing packages from several vendors may not be practical or effective.

To some, ERP has been tainted and given a bad reputation. Due to the backlash of ERP failures, the term "ERP" is intentionally avoided and replaced with titles related to e-commerce solutions. For example, it is interesting to see that the Oracle's recent set of ERP applications is titled "E-Business Suite" and SAP is claming the development of "E-Business Platform" (Radovilsky, 2002).

If this current trend of "ERP" problems continue, it is possible that more and more companies may alter their current IT integration strategies. This may signal the end of ERP as we know it. "In 4 years …basically the whole notion of enterprise application software is going to be dead," proclaimed Halsey Minor, CEO of Hosted Integration Provider Grand Central Communications. Minor's vision is the emergence of the hosted, pay-per-use services and on-demand model to replace the current models of ERP acquisition and implementation. Should IT managers listen to him and believe in his ominous prediction for the end of enterprise IT? Maybe not, but it may not be wise to ignore his message, either. The reason is simple. Putting money where his mouth is, Minor has recently launched a $50 million venture capital fund with his own money to fuel on-demand startups (Knorr, 2004, p. 41). Minor is not alone. Marc Benioff, CEO of Salesforce.com, who originated the "no software" marketing campaign, also shares a similar vision.

If the predictions from people like Minor and Benioff become true, in just a few years all enterprise software would be delivered as a service. Actually, that trend has already begun. Many ASPs, including SAP, currently offer customer-selected applications, such as CRM. It is impossible to know the future with any certainty. Predicting the future direction is an inexact science, especially in the world of IT. Some technology will rise and die. Some will linger. Some will change almost everything they touch. The sparks of innovations in technology are often followed by turbulent changes that are in part driven by emerging business needs, new customer demands and market forces. Such a rapid pace of change has shaped how companies plan their strategies. Jim Goodnight, co-founder and CEO of SAS Institute Inc., realized this as he commented, "the IT industry needs to keep a fairly short horizon. Our horizon is 2 years. We make it practice not to have these big 5-year plans. If you do, you are going to get about halfway through, and the world is going to change" (Whiting, 2004).

ERP Alternatives

ERP implies traditional integration (tightly coupled). A relatively new term, "interface integration" (an oxymoron), seeks to achieve integration with interfaces. Actually, this form of "integration" predates the ERP, as system designers attempted to create solutions to share data among disparate applications. The modern names for this approach are EAI and middleware, to name only a couple. Although not quite integration, these technologies offer many of the benefits of integration.

XML is one proposed solution for sharing data among dissimilar databases (Sullivan, 2000). One of the latest integration fads is Web services. Darwin Partners and ZapThink (2002, p. 1) describe their vision of Web services this way:

"With the downturn in today's economy, Web services shine on organizations like a beacon of hope. ... Web services promise a new level of compatibility across multiple-technology platforms. Many vendors are pouring time and money into Web services and bringing forth a new set of interoperability technologies: XML, SOAP, WSDL and UDDI, to name a few. Web services begin with XML. This straightforward language enables different systems to talk to each other. Web services use XML to create a set of industry-standard protocols for describing and exchanging information and handling transactions between companies. Suddenly, system integration is easier and less expensive ..."

Traditional ERP vendors like SAP and Oracle are also embracing Web services as an integration solution.

Another proposed integration solution is Service Oriented Architecture (SOA). IBM (2005) says SOA "is the blueprint for IT infrastructure of the future. SOA extends the Web services value proposition by providing guidance on how enterprise IT infrastructure should be architected using services." They advocate four SOA levels: (1) individual Web services, (2) service-oriented integration of business functions, (3) enterprise-wide IT transformation, and (4) on-demand business transformation.

Technology Changes, but Not Objectives

While the term ERP (like its predecessor MRP) may be disappearing, the basic objective remains the same—integration of enterprise IT and business process. If we use the more appropriate term, IES (instead of ERP), then clearly that trend continues. As ERP replaces ERP, we similarly see other acronyms are replacing IES. Chief among these are EAI, Web services and SOA.

Conclusion

"An effective corporate strategy can be best thought of as an integrated system in which all of the elements are aligned" (Collins & Montgomery, 2005, p. 2). This idea of integration and alignment is exactly what we have argued both within the domain of IS and the relationship of IS to the firm and, hence, the overall strategy. Integration is clearly fundamental to IS and is the very heart of ERP. ERPs have become a key integration strategy for many organizations, especially those competing in the global marketplace.

Whether the end of enterprise IT comes true, we believe that the evolution of IT strategy will continue. To avoid past mistakes, companies should embrace innovations, react quickly to new opportunities and adapt successfully to environmental changes, but, most important of all, they should maintain a balance between the known and unknown boundary. To achieve all these goals, a well-thought IT strategy must be in place. It should comprise at least three dimensions: (1) use of IT to support organizational strategy, (2) alignment of IT goals with organizational goals, and (3) adoption of various IT and IS technologies. A common objective of all three dimensions is the dimension of integration. However, the focus of integration is now extending beyond data, information and applications. We observe that the trend for future IT strategy is on integration of several infrastructures that have emerged as technology rapidly advanced during the past couple of decades.

During the last several years, the emphasis of senior IS professionals has shifted to architecting and infrastructure (Cross et al., 1997). IT infrastructures have been the focus of much research during the past two decades. An IT integration infrastructure is defined as the integration of all IT infrastructures within an organization, which is an artificial mechanism created by the organization to meet its specific needs. An integration infrastructure is the "glue" that holds together all of the various IT infrastructures to create the desired synergy, and thereby facilitating coordination among the infrastructures, which allows them to work together. One indicator of IT infrastructure importance is the magnitude of the investments that firms have been willing to make. For instance, the costs of an IT infrastructure can exceed 50% of the total IT budget in large companies (Broadbent & Weil, 1997). This seems perfectly reasonable, since, "Increasingly, infrastructure is viewed as the enduring IT resource …" (Cross et al., 1997, p. 408). Therefore, we believe that it is important to understand, view and evaluate the integration of the requisite IT infrastructures needed by organizations. The growth of integration of IT infrastructure will be an important topic for both the practitioners as well as researchers in the area of IT.

ERP has and continues to be a very important integration strategy for organizations, as evidenced by the massive annual investments in this technology. Clearly, there are signs of major changes afoot as new technologies emerge and gain momentum. IESs will likely remain a major IT strategy for most organizations in the foreseeable future. While the name ERP may change, the needs and objectives remain the same.

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Endnotes

1 The source for this section is Singletary (2004).

2 Sor was referring to Gleick: "… a butterfly stirring the air in Peking today can transform (into) storm systems next month in New York" (1987, p. 8).

3 The sources for this section are Singletary (2003) and Singletary and Watson (2001).

4 The source was not available in print at the time the chapter was written.

Chapter VIII

Marketing Strategy: The Role of Information Technology-Enabled Capabilities

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Abstract

Because of (1) the boundary-spanning nature of the marketing function, and (2) marketing's evolution toward a dynamic, evolutionary process, and service-centered view, marketing strategy has come to be a core element of the firm's business strategy. That is, in an information-intensive, competitive marketplace, marketing strategy is responsible for ensuring that all aspects of a firm's marketing activities are focused on delivering superior value to customer. Further, recognizing information/knowledge and information technology (IT) as potential sources of competitive advantage, this chapter explores various IT-enabled capabilities that influence the firm's marketing strategy. In doing so, specific IT-enabled capabilities that correspond to Market Orientation Strategy, Relationship Marketing Strategy, Market Segmentation Strategy, and Brand Equity Strategy are presented and discussed. Finally, this chapter concludes with a call for strategically oriented research for exploring, conceptualizing, developing, and measuring IT-enabled capabilities that influence marketing strategy.

Introduction

Over the last two decades, a number of scholars in the field of marketing have worked on the changing, evolving, and boundary-spanning role of marketing in the organization (Achrol, 1991; Day, 1994; Homburg, Workman, & Krohmer, 1999; Vargo & Lusch, 2004; Webster, 1992). These works suggest a significant role for marketing in business strategy. Achrol (1991) notes that, in the post-industrial era, marketing has become a critical managerial activity that is boundary spanning in nature. Webster (1992) advocates that marketing is the management function responsible for making sure that every aspect of the business is focused on delivering superior value to customers in the competitive marketplace. Day (1994) argues that market-driven organizations are superior to their competitors with reference to two marketing-related capabilities that influence the firm's overall strategy: market-sensing and customer-linking capabilities. Homburg et al. (1999) provide empirical support and claim that marketing has substantial influence on strategic decision making within the organization. Finally, in a recent award-winning and potentially seminal article, Vargo and Lusch (2004, p. 14) claim that marketing is evolving toward a dynamic, evolutionary process, service-centered view and, hence, "marketing should be positioned at the core of the firm's strategic planning." That is, as Hunt and Derozier (2004) note, there is a significant overlap between and marketing strategy and business strategy. However, what role do IT and IT-enabled capabilities play in a firm's marketing strategy?

With the advent of the information-intensive economy, concepts such as "IT" and "IT capability" are gaining prominence. These phrases record approximately 93,000,000 and 5,200 hits, respectively, in a search engine. However, scholarly research has been somewhat slow in investigating these concepts. For example, EBSCO, an academic and business research database, records approximately 127,000 and 87 hits, respectively, for the same phrases. Specific to the field of marketing, over the years researchers have been showing an increasing interest in the role of information and/or IT in marketing strategy. However, researchers have mainly looked at IT from a tactical perspective rather than a strategic perspective. That is, "IT" has often been looked at as a tool that helps marketing decision makers. Nonetheless, in the last decade, some marketing researchers have begun to investigate the role of IT-related capabilities in marketing strategy success (e.g., Day, 1994; Hunt, Arnett, & Madhavaram, 2006). In fact, Varadarajan and Jayachandran (1999) identify IT as strategy content that, in today's economy, demands the attention of scholarly research. Therefore, in this chapter, we explore and discuss how IT relates to some of the common forms of marketing strategies and the corresponding IT-enabled capabilities with reference to the different marketing strategies.

The chapter is organized as follows: First, we provide the necessary background for the chapter along with a definition for *IT-enabled capability*. Second, we trace the role of IT with reference to the marketing function. Third, we discuss four specific forms of marketing strategy: relationship marketing strategy, market segmentation strategy, market orientation strategy and brand equity strategy. In this section, we discuss the roles of various IT-enabled capabilities with reference to each of the four forms of marketing strategy. Fourth, we conclude with a discussion of the contributions of this chapter and future research directions.

Background

At the beginning of the 19th century, Veblen (1919) contended that loss of knowledge and skills would be much more destructive compared to the loss of material equipment. As Hodgson (2000) notes, the reconstruction and dynamic recovery in Germany and Japan after the wholesale industrial devastation in the Second World War lends strong support to Veblen's argument. That is, competitive advantage is migrating from tangible resources to intangible resources within an organization. Specifically, Wright (1996) elaborates on the resource-based view and argues that (1) human capital and organizational capital tend to be knowledge-based, and (2) these knowledge-based resources are the primary enabling and constraining factors in the development of innovation and competitive advantage. In fact, as McKee (1992) suggests, organizational learning may be the only competitive advantage open to a firm in the future. Consequently, we argue that IT-related capabilities that facilitate, develop, guide, and create knowledge can be *potential* sources of competitive advantage.

In the marketing strategy literature, researchers have long since recognized the role of information/knowledge as a potential source of competitive advantage (e.g., Glazer, 1991; Li & Calantone, 1998; Li & Cavusgil, 2000; Madhavan & Grover, 1998). For example, Glazer (1991) asserts that the economy will continue to be information-intensive based on the theoretical arguments of (1) the apparently inevitable substitution of information/knowledge for capital and labor, and (2) the inherently non-scarce and seemingly unlimited renewable and regenerative aspects of information/knowledge. In management literature, Peter Drucker, who coined the terms "knowledge work" and "knowledge worker," is one of the earliest thinkers to have noticed the transformation of manufacturing-based industrial society to "the knowledge society." This indicates that in a knowledge society, "the basic economic resource" is no longer capital, natural resources, or labor, but "is and will be knowledge" (Drucker, 1993). In addition, researchers from disciplines such as economics (Cohendet, 2001; Fransman, 1994) and corporate strategy (Baden-Fueller & Pitt, 1996; Grant, 1996; Nelson & Winter, 1982) have started paying greater attention to the firm as a knowledge processor and body of knowledge, respectively. According to this perspective, the firm is (1) essentially used as a locus of setting up construction, selection, usage, and development of knowledge, and (2) sensitive to sharing and distribution of knowledge/information. We contend that technology that facilitates the efficient and effective sharing of information/knowledge has potential to provide firms with a competitive advantage. Therefore, in this chapter, we argue that a firm's IT-related capabilities have a significant role to play in developing, sharing, using, and interpreting marketing-related knowledge/information. Further, such capabilities can develop, inform, support, facilitate and guide marketing strategies and, hence, can be potential sources of sustainable competitive advantage. In the Management Information Systems (MIS) literature, with the exception of a few researchers (Bharadwaj, 2000; Goslar, 1986; Kocas, 2002; Romano, Donovan, Chen & Nunamaker, 2003), not many have addressed the issue of the influence of IT capabilities on marketing strategy.

However, what is an *IT capability*? Extending the traditional notion of organizational capabilities to a firm's IT function, Bharadwaj (2000, p.171) defines a firm's IT capability as "its ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities." The definition that we use in this chapter, though consistent with Bharadwaj's (2000) definition, is broader and more specific at the same time. Following Hunt (2000), we define IT-enabled capabilities as socially complex, interconnected combinations of tangible basic resources (e.g., specific machinery, computer software and hardware) and intangible basic resources (e.g., specific organizational policies and procedures and the skills, knowledge and experience of specific employees) that fit together coherently in a synergistic manner to enable firms to produce efficiently and/or effectively valued market offerings. That is, (1) tacit knowledge, such as embedded in organizational policies and procedures; (2) explicit knowledge of individuals and organizations, and (3) processes to integrate and generate knowledge when coupled with basic tangible resources such as computers (machinery), intranets, extranets and Internet-related hardware and other machinery becomes an IT-enabled capability. Further, because of the intangible resource and tacit knowledge components, IT-enabled capabilities exhibit characteristics such as (1) inimitability, because processes of generating knowledge are embedded in organizational cognitive activities and are not observed readily from outside (Day, 1994; Prahalad & Hamel, 1990); (2) immobility, because these processes are created within the firm and cannot be purchased in the market (Day, 1994); and (3) undimnishibility, because unlike machines, whose value depreciates over time, the utility of these capabilities does not diminish with usage (Prahalad & Hamel, 1990). Therefore, IT-enabled capabilities can potentially be sources of sustainable competitive advantage in the context of marketing strategy.

Marketing Strategy and IT

Marketing researchers noted the significance of IT for marketing more than four decades ago (e.g., Christian, 1962; Kotler, 1966). Commenting on the usefulness of computer technology for marketing purposes, Christian (1962) notes that (1) the application of computer technology will have a positive influence on most marketing functions, such as selling, new product development, communications, and marketing research; and (2) computer technology and the marketers will have a long and fruitful association in years to come. Recently, Varadarajan and Jayachandran (1999) assessed the state of the marketing strategy field and identified *impact of IT* as one of the important areas for future research. For Varadarajan and Jayachandran (1999), advances in IT may provide firms with (1) more interactive media that serve as a platform for communication as well as a channel for selling; and (2) information that determines the competitive advantage of firms, innovation undertaken by firms and their diversification options. A brief history of research related to IT and marketing is presented chronologically in Table 1.

Around the same time, in an article on marketing strategy, Menon, Bharadwaj, Adidam and Edison (1998) propose innovative culture as an antecedent to marketing strategy making. Menon et al. (1998) argue that, because innovative cultures focus on information and rational processes, they increase the propensity to analyze information. Further, they note that innovative cultures thrive when diverse functional groups find it easy to

Table 1. A chronological overview of research concerning marketing and IT

Key Articles	Implications
Christian (1962)	Computer technology and marketing man – indispensable partners in progress
Kotler (1970)	IT and sophisticated marketing decision models will make the marketing executive more analytical and innovative.
Montgomery, Urban, Abrams, Frank, Green, Kadushin & Warwick (1970)	Call for efforts to take full advantage of the new IT and identify new developments.
Glazer (1991)	Presents a framework for thinking about the impact of information and IT on marketing.
Day (1994)	Contends that creative use of IT may influence market-driven organizations positively.
Leverick, Littler, Bruce & Wilson (1998)	Give examples of application of IT to marketing, such as sales analysis and forecasting, customer segmentation, analysis of survey data and so on. Provide a list of potential barriers to the use of IT in marketing: technological, organizational, personal and other barriers.
Li, Kinman, Duan & Edwards (2000)	Identify and discuss various types of systems, such as Marketing Information System (MKI), Decision Support System (DSS), Executive Information System (EIS), Expert System (ES), Artificial Neural Network (ANN) and fuzzy logic in the context of marketing strategy development, and present results of survey exploring issues with various systems.
Brady, Saren & Tzokas (2002)	Identify various IT components relevant to marketing practice, such as databases, communications-related IT, CRM-related IT, hardware, sales-related IT, research-related IT, analysis and planning-related IT, office packages,- and self-service technologies. Urge for integrating IT into marketing practice

share and exchange ideas. Therefore, IT that facilitates sharing, exchanging, and analyzing information can also positively influence the firm's marketing strategy.

While the works of Varadarajan and Jayachandran (1999) and Menon et al. (1998) provide a general idea as to the influence of IT on marketing strategy, the works of Brady, Saren and Tzokas (2002); Goslar (1986); Leverick, Littler, Bruce and Wilson (1998); and Li, Kinman, Duan and Edwards (2000) provided some specifics with reference to the role of IT in marketing strategy. Brady et al. (2002) present a general list of various IT components that can aid marketers and urge conscious assimilation of IT into marketing practice. Goslar (1986) provides a specific list of components for an ideal marketing decision support system. Leverick et al. (1998) confer (1) some examples of applications of IT in marketing, (2) potential barriers to the use of IT in marketing, and (3) factors associated with effective IT applications in marketing. Li et al. (1998) surveyed 104 companies and discussed different types of computer-based systems, such as MKI, DSS, EIS, ES, ANN systems, and fuzzy logic systems that can be used to develop marketing strategy.

However, most of the work on influence of IT on marketing seems to be too general and lacking in providing any specific details of influences on marketing strategy. That is, while earlier marketing research predicted a greater role for IT in marketing strategy, current research seems to exhibit more of a tactical orientation than a strategic orientation. Therefore, in this chapter, we discuss the influences of various IT-enabled

Table 2. Forms of marketing strategy and corresponding IT-enabled capabilities

Forms of Marketing Strategy (Hunt and Madhavaram, In press)	**IT-Enabled Capabilities**
Market Orientation Strategy	Knowledge Infrastructure Capability (Gold, Malhotra & Segars, 2001) Internet-mediated market Orientation Capability (Min, Song & Keebler, 2002) Market Sensing Capability (Day, 1994)
Market Segmentation Strategy	Knowledge Infrastructure Capability (Gold, Malhotra & Segars, 2001) Marketing Decision Support System Capability (adapted from Goslar 1986)
Relationship Marketing Strategy	Customer Linking Capability (Day 1994) Inter-organization IS Capability (Adapted from Johnston & Vitale (1988) and Gold, Malhotra & Segars (2001)) Customer Relationship Management Capability (Dowling, 2002)
Brand Equity Strategy	Knowledge Infrastructure Capability (Gold, Malhotra & Segars, 2001) Marcom Database Management Capability (Peltier, Schibrowsky & Schultz, 2003)

capabilities on marketing strategies. Specifically, in the next section, we discuss (1) the four different forms of marketing strategies discussed by Hunt and Madhavaram (n.d.), and (2) the influences of specific IT-enabled capabilities on each of the four different forms of marketing strategy. Table 2 provides potential IT-enabled capabilities that influence the forms of marketing strategy. These different forms are not mutually exclusive and could potentially influence each other. For example, market orientation strategy, which focuses on customer needs, wants and preferences, can be related to a firm's market segmentation strategy.

Forms of Marketing Strategy and Corresponding IT-Enabled Capabilities

Market Orientation Strategy

For Shapiro (1988), an organization is market oriented only if information on all important buying influences permeates every corporate function. Further, Selnes and Wesenberg (1993) explain market orientation as a response to market information. Concomitantly, Kohli and Jaworski (1990) consider information as a focal point for market orientation, and conceptualize market orientation as the implementation of the marketing concept that focuses on the firm's activities and behaviors regarding customer needs, competitive information, market intelligence and the sharing of such knowledge across organizational functions. They formally define market orientation as "the organization-wide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across departments, and organization-wide responsiveness to it" (Kohli & Jaworski, 1990, p. 6). Hunt and Morgan (1995) propose that market orientation is:

1. The systematic gathering of information on customers and competitors, both present and potential.
2. The systematic analysis of information for the purpose of developing market knowledge.
3. The systematic use of such knowledge to guide strategy recognition, understanding, creation, selection, implementation and modification.

According to this conceptualization, market orientation: (1) involves organization-wide generation and dissemination of information about customers and competitors, and (2) potentially develops market knowledge that is usable to guide strategy recognition, understanding, creation, selection, implementation, and modification. Therefore, for Hunt and Morgan (1995), the fundamental imperative of market orientation strategy is that, to achieve competitive advantage and, thereby, superior financial performance, firms should systematically gather information on present and potential customers and competitors and use such information in a coordinated way across departments to guide strategy recognition, understanding, creation, selection, implementation, and modification. Hence, we argue that IT-enabled capabilities, such as knowledge infrastructure capability (Gold et al., 2001), market sensing capability (Day, 1994) and Internet-mediated market orientation (IMO) capability (Min, Song, & Keebler, 2002), influence a firm's market orientation strategy.

Knowledge Infrastructure Capability

This capability consists of three key infrastructures, namely, technical, structural and cultural. Those enable the maximization of social capital, "the sum total of actual and potential resources embedded within, available through and derived from the network of relationships possessed by a social unit" (Gold et al., 2001, p. 187). We can clearly see the benefits of the three key infrastructures: (1) The technology infrastructure helps integrate the previously fragmented information and knowledge through the linkage of information and communication systems in an organization (Argyris & Schön, 1978; Duncan, 1972; Teece, 1998); (2) As Gold et al. (2001) argue, organizational structure is important in leveraging technological architecture; however, structural elements have often had the consequence of inhibiting collaboration and sharing of knowledge across internal organizational boundaries; (3) Gold et al. (2001) identify organizational culture as perhaps the most significant hurdle to effective knowledge management. Also, shaping culture is central in an organization's ability to manage its knowledge more effectively (Davenport, DeLong, & Beers, 1998; Davenport & Klahr, 1998; Leonard-Barton, 1995). Hence, organizational culture that encourages employee interaction and collaboration is extremely important for an organization to integrate and generate new knowledge. Given that technological infrastructure is an important part of the firm's knowledge management capability, knowledge management capability is an IT-enabled capability that influences positively the firm's market orientation strategy.

IMO Capability

Min et al. (2002, p.3) define IMO as the "*Internet-mediated, information-rich, seamless, agile and boundary-spanning process* of generating, disseminating, and responding to market information on the Internet" (italics in original). Further, Min et al. (2002) argue IMO as a technological tool that can be used to implement a firm's market orientation strategy. However, as suggested by Kohli and Jaworski (1990), we argue that the Internet can only be one of the facilitating tools for implementing a firm's market orientation strategy. However, a firm's IMO capability can influence positively the firm's market orientation strategy. Clearly, a firm's IMO capability is an IT-enabled capability.

Market Sensing Capability

For Day (1994, p. 43), in market-driven firms, "the processes for gathering, interpreting and using information are more systematic, thoughtful, and anticipatory than in other firms." Further, Kohli and Jaworski's (1990) behavioral definition of market orientation captures the essence of a market sensing capability. Since market-driven firms have an anticipatory capability achieved through open-minded enquiry, synergistic information distribution, mutually informed interpretations and accessible memories, they sense events and trends in their markets ahead of their competitors. We argue that the anticipatory capability of the market-driven firm will be better with supportive IT. Therefore, we propose that such "market-sensing capability" is an IT-enabled capability that helps firms in sensing and responding to markets ahead of competition.

Market Segmentation Strategy

Market segmentation is based on the assumption that customers demonstrate heterogeneity in their product preferences and buying behavior (Wind, 1978). Once the heterogeneous markets are divided into smaller segments of consumers with similar wants, needs, tastes and preferences, firms can devise specific marketing mixes for specific target segments. That is, market segmentation strategy requires that "to achieve competitive advantage and, thereby, superior financial performance, firms should (1) identify segments of industry demand, (2) target specific segments of demand, and (3) develop specific marketing "mixes" for each targeted market segment" (Hunt & Arnett, 2004, p. 7).

Leigh and Marshall (2001) observe that IT can be used "to build competitive advantage by more effectively and efficiently managing *information* systems, especially those that emphasize *market* and customer tracking, customer preference analysis and enhanced buyer-seller interactions. Clearly, IT plays a critical role in enabling customer focus, close customer relationships and *market* adaptability." Therefore, IT enabled capabilities with reference to tracking, analyzing preferences, and enhancing buyer-seller interactions in each market segment could potentially contribute the success of market segmentation strategy.

Using the work of Wilkie and Cohen (1977), Dibb (1998) summarizes the priorities of segmentation research for academics and practitioners. Segmentation is a process that involves: (1) the actual behavior of customers; (2) search for variables that explain the variables; (3) techniques for analyzing the data; (4) use of statistical approaches, such as multiple regressions, conjoint analysis; and (5) use of information to target specific segments with appropriate marketing mixes. For Hunt and Arnett (2004), market segmentation is not limited to use of particular statistical techniques for identifying groups of potential customers, but is a strategic process that includes: "(1) identifying bases for segmentation; (2) using the bases to identify potential market segments; (3) developing (portfolios) of segments that are strategic alternatives; (4) ascertaining the resources necessary for each strategic alternative; (5) assessing existing resources; (6) selecting an alternative that targets a particular market segment or market segments; (7) securing the resources necessary for the target(s); (8) adopting positioning plans for the market offerings for the segments; and (9) developing marketing mixes appropriate for each segment" (p. 8). This strategic process involves (1) gathering meaningful information on customers; (2) analyzing the information for developing, planning and implementing the specific marketing mix strategies; and (3) coordinating various resources and knowledge of various employees for successful implementation. Clearly, firms need IT-enabled capabilities for successful implementation of market segmentation strategy. We argue that a firm's knowledge management capability and market sensing capability influence positively the firm's market segmentation strategy.

Marketing DSS Capability

Goslar (1986) claims that the flexibility and accessibility of DSS for individual and group decisions offer substantial improvement in decision and information assistance than traditional MIS. Further, Goslar (1986) finds that marketing DSS offer able assistance for ill-structured, strategically oriented decision scenarios. Drawing from Goslar's (1986) conceptualization of the components of an ideal marketing DSS, we argue that a marketing DSS capability should involve abilities to (1) integrate and/or transform divergent data to create non-repetitive problem scenarios; (2) analyze ill-structured problems involving aggregation, transformation and pattern recognition capabilities using sophisticated parametric and non-parametric analytical tools; (3) develop heuristic and analytic models with stochastic features that closely represent marketing problems; and (4) facilitate flow of information in forms most effective for the marketer.

Relationship Marketing Strategy

Hoffman (2000) notes that the building of trust and commitment make relationship marketing rare and difficult to imitate. Therefore, relationship marketing could be a potential source of competitive advantage. Morgan and Hunt (1994, p. 22) conceptualize relationship marketing as referring to "all marketing activities directed toward establishing, developing and maintaining successful relational exchanges." Hunt (1997) conceptualizes relationship marketing strategy as "to achieve competitive advantage and, thereby, superior financial performance, firms should identify, develop and nurture an efficiency-enhancing, effectiveness-enhancing portfolio of relations."

In this chapter, we specifically address the relational exchanges with reference to buyer partnerships (with intermediate and ultimate customers), supplier partnerships (with goods and services suppliers), and internal partnerships (with employees, functional departments and business units). Relationship marketing theory notes that collaborative relationships require considerable transfer of technology and knowledge sharing among partners. As a result, Hunt, Arnett and Madhavaram (2006) note that successful relationship marketing-based strategies often require firms to adopt inter-organizational IS and create organizational processes conducive to knowledge use and sharing. With reference to relationships internal to the firm, knowledge infrastructure capability will have a positive influence. With reference to relationships with suppliers, inter-organizational IS coupled with technical infrastructure of the focal firm can potentially have a positive influence. We conceptualize such a combinative capability as "*inter-organizational IT capability*."

To improve the success of interorganizational IS, firms must also adapt their existing infrastructures in ways that facilitate the collaboration and sharing of knowledge across internal organizational boundaries (Gold et al., 2001). A firm's infrastructure must link its IS with its communication systems. As Menon and Varadarajan (1992, p. 53; italics added) emphasize, "relevant information must be produced *and* disseminated to the various departments and managers in the most appropriate form to enhance use." Therefore, inter-organizational IT capability that combines (1) inter-organizational IS and (2) IT infrastructure of the focal firm facilitates knowledge use and knowledge sharing through better internal communication flows.

With reference to relationships with customers, a customer-linking capability as conceptualized by Day (1994) that refers to creating and managing close customer relationships is becoming important for firms. Such a *customer linking capability* involves (1) close communication and joint problem solving, and (2) coordinating activities. Similarly, following Dowling (2002), firms with *CRM capability* involve (1) a relationship management component (e.g., support teams and loyalty programs), and (2) a data-driven component (e.g., identifying profitable segments through statistical techniques). With the help of IT, these two components can be used to develop marketing strategies that have a long-term relationship orientation.

Brand Equity Strategy

Kitchen, Brignell, Li, and Jones (2004, p. 28; italics added) point out that "only strategically oriented integrated *brand* communications can help businesses move forward in the highly competitive world of the 21st century." For Schultz (1998), brands are central to this integrated marketing communication. Keller (1993) points out that customer-based brand equity emanates from the consumers' familiarity and strong, favorable associations with the brand. That is, marketing communications provide the means for developing strong, customer-based brand equity. For Keller (2001, p. 823), marketing communications represent the voice of a brand and the means by which companies can establish a dialog with consumers concerning their product offerings."

Keller (2003) points out that a firm's marketing communications contribute to brand equity. That is, effective communication enables the formations of brand awareness and a positive brand image that form the brand knowledge structures, which, in turn, trigger differentiated response that constitutes brand equity. For Hunt (2006), to achieve competitive advantage and, thereby, superior financial performance, firms should acquire, develop, nurture and leverage an effectiveness-enhancing portfolio of high-equity brands. Kitchen et al. (2004) note that organizations (1) gather extensive information about their customers and (2) use that information for deploying marketing communications and evaluating feedbacks. For this purpose, firms need IT-enabled capabilities with reference to database management and information-intensive customer communication strategies.

Schultz and Kitchen (2000) discuss the role of IT in integrated marketing communication. For them, integrated marketing communication requires: (1) a high degree of interpersonal and cross-functional communication inside and outside the organization; (2) extensive information about customers; (3) accessible data sources and databases that help in effectively integrating customer information into communication planning and implementation; (4) monitoring of marketing communications from a return-on-investment perspective; and (5) continuously developing customer knowledge with reference to each of the target market segments.

Marketing Communications (Marcom) Database Management Capability

Peltier, Schibrowsky, and Schultz (2003) present a conceptual model of the relationship between database management and interactive integrated marketing communication. For Peltier et al. (2003), database management involves: (1) data collection through traditional and online surveys, Web site tracking, e-mail responses, warranty cards, internal records, appended data and other data; (2) customer database development that incorporates demographics, psychographics and behavioral data; and (3) customer relationship management development that involves forming relational segments and profiling and prioritizing various target segments. Consequently, specific integrated marketing communication programs can be developed, keeping all the target segments in mind.

Conclusion

Given that (1) marketing function is boundary spanning in nature; (2) marketing strategy is a core element of business strategy; (3) marketing information/knowledge can potentially provide organizations with competitive advantages; and (4) technology that can influence the development, creation, exchange, use, and interpretation of information/knowledge, in turn, can be a potential source of competitive advantage, we explore the role of IT-enabled capabilities in different forms of marketing strategy.

This chapter makes several contributions to the literature. First, in the background section, we provide basis from literature that information/knowledge and IT-related capabilities can be *potential* sources of competitive advantage. Second, we provide a definition for IT-enabled capabilities and provide rationale for how IT-related capabilities can be *potential* sources of competitive advantage. Third, we provide a discussion of literature related to marketing strategy and IT. Fourth, we provide specific IT-enabled capabilities with reference to each of the four forms of marketing strategy. In doing so, we discuss (1) the four different forms of marketing strategy and (2) influences of specific IT-enabled capabilities on each of the four different forms of marketing strategy. Fifth, the specific IT-enabled capabilities provided in this chapter provide academics and practitioners opportunities to focus on specifics with reference to respective marketing strategies. Overall, our chapter provides a foundation for exploring IT-enabled capabilities in the context of marketing strategy.

Further, our work offers the basis for several future research opportunities. For example, with reference to qualitative research, case studies of firms that use the specific forms of marketing strategies could be conducted to explore IT factors that give competitive advantage to the corresponding firms. Such studies may provide a rich understanding of the IT factors that can potentially (1) influence marketing strategy and (2) provide competitive advantages. In addition, in-depth interviews of marketing managers, IT managers and employees of the firms responsible for marketing related IT could provide insights into enriching our understanding. Further, focus group discussions among select groups of employees exposed to the firm's proposed marketing-related IT options could provide additional inputs for better integrating marketing strategy and IT.

Moreover, researchers could also aim to (1) conceptualize and develop a more comprehensive list of IT-enabled capabilities with reference to each of the different forms of marketing strategy; (2) explore individual-, group-, organizational- and inter-organizational-level antecedents to an organization's information-enabled capabilities; and (3) empirically test the various models involving antecedents and specific marketing strategy consequences pertaining to IT-enabled capabilities. Empirical tests using such methods as survey research could potentially offer more generalizable results. Scales for IT-enabled capabilities can be developed using items adapted from other scales or created anew. Using surveys, researchers could sample key informants in organizations who are knowledgeable about marketing strategy and as well as IT capabilities. Overall, with reference to future research, we present our chapter as (1) a foundation for further theory development and (2) a starting point for future research. We hope that future research in the area of IT-enabled capabilities and marketing will provide organizations with opportunities for developing competitive advantages.

In conclusion, information and IT can provide organizations with opportunities to come up with essential and timely strategic information that, in turn, makes them effective and/or efficient compared to competitors. Further, IT-enabled capabilities can *potentially* provide organizations with competitive advantages. In this chapter, we showed that IT-enabled capabilities have a significant role to play in developing, informing, supporting, facilitating, and guiding marketing strategy. Hence, both for academics and practitioners, conceptualizing and developing IT-enabled capabilities are a worthwhile pursuit to which this chapter offers an initial contribution.

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Section III:

Technology and Tools

Chapter IX

Linking Businesses for Competitive Advantage: A Mobile Agent-Based Approach

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Abstract

In a highly competitive business environment, every organization is trying to achieve more using fewer resources. This is particularly true in this Internet era, where many businesses are moving from "brick-and-mortar"-based operation towards having at least an Internet presence, where e-commerce is fast gaining acceptance. Recent advances in mobile agent technology promise yet another powerful tool to gain competitive advantage—to deliver cost-effective services through utilizing Internet infrastructure. Such a development helps both individuals and organizations achieve higher productivity at lower cost. In this chapter, the authors describe an intelligent mobile agent-based system that links hotels and restaurants to provide gourmet goers with a convenient way of searching for their choice restaurants. The system sends off intelligent mobile agents to automatically roam the Internet, gather the relevant information about food and services from participating restaurants, and provide the most optimized selection as suggestions to help the users make their meals decision.

This greatly reduces information overload for the users. Participating business establishments also benefit, through increased business.

Introduction

Agent-based systems have gained prominence over the last few years. One of the most interesting categories of agents is mobile agents (Lange & Oshima, 1998). Unlike static agents, which are restricted to operate within a single machine or address space, mobile agents have the ability to migrate over the network, execute tasks at each location and potentially interact with other agents that cross their paths. Advantages of mobile agents include their ability to reduce network usage, increase asynchrony between clients and servers, add client-specified functionality to servers and introduce concurrency. These features help lower computing costs of modern businesses as well as better manage network traffic, as illustrated below.

Many online business transactions involve processes that require extensive database searches and matches. For example, users of an online bookstore are likely to view various catalogs, matching descriptions with preferences they have in mind before deciding which books to purchase. As such, information search and filtering applications often download and process large amounts of server-resident information and generate comparatively small amounts of result data. The scenario is greatly different with a mobile agent-based system, where mobile agents move to and execute on server machines and access server data without using the network, reducing bandwidth requirements. Many of today's applications involve repeated client-server interactions, which require either maintaining a network connection over an extended period or making several separate requests. If mobile agents are used instead, the client system does not have to maintain a network connection when its agents access and process information. This permits increased asynchrony between the client and server. This feature is especially useful for mobile computers (such as laptops and PDAs), which typically have low-bandwidth, unreliable connections to the network and are often switched off to save power consumption. Also, the repeated client-server interactions are reduced to two agent-transfer operations, reducing the frequency of network usage, as well.

An example of a user-level application would be an electronic marketplace. Vendors can set up online shops, with products, services or information for sale. A customer's agent would carry a shopping list along with a set of preferences, visit various sellers, find the best deal based on user preferences and purchase the product using digital forms of cash. An added advantage of such a system is that businesses may also be linked up to form a chain, such that mobile agents may move between stores within a business chain to make their purchases. Such a setup will enhance the competitive advantages of participating online stores.

Apart from mobility, a mobile agent-based system will need mechanisms for restricted resource access, secure electronic commerce, protection of agent data, robustness and user control over roaming agents. These will be discussed in later sections.

Mobile Agents: Issues and Developments

Agents-Enabled Electronic Commerce

Mobile agents offer a number of useful possibilities:

- The agent can express the application-level protocol required to perform a transaction. This includes dialogs on choices and options, configurations, availability, delivery methods and opportunities for setting up, as well as complete and accurate capture of information required by the vendor in a particular format. Mobile agents technology is a plausible method for vendors to distribute the client end of a transaction protocol in a device-independent way.
- Alternatively, the mobile agent may be able to present the consumer's desire as a query to a number of potential vendors to determine degree of match, price, availability and so forth.
- The agent may also be able to consult a "consumer guide" or other advisor before making a purchase.
- The agent can provide a secure vehicle for the transaction, providing bilateral authentication and privacy.
- The agent can provide a transaction currency for settlement. The agent's account is presumably reconciled periodically against "real" money.

To facilitate the development of mobile agents distributed applications, and to overcome some problems and issues that arise from this approach, some requirements must be addressed. Systems that support the use of the mobile agent paradigm have to provide a basic set of services and characteristics. These will be discussed later.

Achievable Competitive Advantages Using Mobile Agent-Based E-Commerce Platforms

While many potential competitive advantages can be achieved using a mobile agent-based e-commerce system, the following are being highlighted:

1. **Efficient supply chain management:** Enterprises may link up to provide a wider range of products and services to customers. This will likely attract a larger customer base, and benefits all parties involved. For example, by linking up a hotel server with restaurant chain servers, guests in the hotel get the impression of a wider range of cutlery service available. The restaurants, on the other hand, make

their presence noticed and are likely to get more business. All these can be achieved by the mobile agent applications "weaving" through the servers to retrieve and recommend cutlery establishments that match the hotel guests' preferences.

2. **Effective inventory control:** Many businesses have stores and shop-fronts at multiple locations. To minimize overstocking of inventories and tie up precious cash flow, many businesses keep their inventory low. However, this risks loss of sales when a customer wants goods that are out of stock at a certain branch store. The situation can be saved if such businesses link up their store-front computers using a mobile agent-based system. Such a system will enable a shopkeeper to find the availability of certain stock that matches a customer's request, thus capturing sales instead of letting a customer walk out of the shop and be disappointed.
3. **Powerful information searches for decision making:** Accessibility to information are crucial for important decision making such as loan approval—especially if the quantum is big. Using this example, credit providers may join a bureau which captures the 'worthiness' of private individuals. An agent-based system may be deployed to consolidate the credit situations of a loan applicant with various banks by utilizing the restricted access rights to the bureau controlled databases. This will help the loan approving officers to make informed decision and hence reduces bad debt for the lenders.

Agent Mobility

The primary identifying characteristics of mobile agents is their ability to autonomously migrate from host to host. Thus, support for agent mobility is a fundamental requirement of the agent infrastructure. An agent can request its host server to transport it to some remote destination. The agent server must then deactivate the agent, capture its state and transmit it to the server at the remote host. The destination server must restore the agent state and reactivate it at the remote host, thus completing the migration.

The state of an agent includes all its data, as well as the execution state of its thread. At the lowest level, this is represented by its execution context and call-stack. If this can be captured and transmitted along with the agent, the destination server can reactivate the thread at precisely the point where it requested the migration. An alternative is to capture the execution state at a higher level, in terms of application-defined agent data. The agent code can then direct the control flow appropriately when the state is restored at the destination.

Security Issues

The introduction of mobile agent code in a network raises several security issues. In an open network, such as the Internet, it is entirely possible that the agent and server belong to different administration domains. In such cases, they will have much lower levels of mutual trust. Servers are exposed to the risk of system penetration by malicious agents, analogous to viruses and Trojan horses. Security-related requirements are discussed in the following sections.

Privacy and Integrity

Agents carry their own code and data with them as they traverse the network. Parts of their state may be sensitive and need to be kept secret when the agent travels on the network. For example, a shopper agent may carry its owner's credit card number or personal preferences. The agent transport protocol needs to provide privacy to prevent eavesdroppers from acquiring sensitive information. Also, an agent may not trust all servers equally. We need a mechanism to selectively reveal different portions of the agent state to different servers. For example, a shopping agent may solicit quotations from various vendors. To ensure fairness, one vendor's quotation must not be readable or modifiable by others.

A security breach could result in the modification of the agent's code as it traverses the network. We need some means of verifying that an agent's code is unaltered during transit across a distrusted network or after visiting a distrusted server. An agent's state typically needs to be updated during its journey so it can collect information from servers. While we cannot assume that all servers visited are benign, we can provide mechanisms that allow such tampering to be detected.

Cryptographic mechanisms can be used to provide a secure communication facility, which an agent can use to communicate with its home site, or servers can use to transport agents safely across distrusted networks. Selective revealing of state can be accomplished by encrypting different parts of the state with different public keys belonging to the servers allowed to access those parts of the state. Mechanisms such as seals can be used to detect any tampering of agent code.

Authentication

When an agent attempts to transport itself to a remote server, the server needs to ascertain the identity of the agent's owner to decide what rights and privileges the agent will be given in the server's environment. A vendor's server needs to know the visiting agent's identity to determine which user to charge for service rendered. Conversely, when an agent migrates to a server, it needs some assurance of the identity of the server itself before it reveals any of its sensitive data to the server. Digital signature systems have been used to develop mutual authentication schemes. To verify signatures, agents and servers need to reliably know the signing entity's public key. This requires a key certification infrastructure. Public keys certified by trusted agencies can be posted in network-wide directories that can be accessed by agents and servers.

Authorization and Access Control

Authorization is the granting of specific resource access rights to specific principles (such as owners of agents). Some principals are more trusted than others, and thus, their agents can be granted less-restrictive access. This involves specifying policies for granting access to resources based either on identities of principals, their roles in an organization or their security classification.

Metering and Charging Mechanisms

When agents travel on a network, they consume resources, such as CPU time, disk space and so forth at different servers. These servers may legitimately expect to be reimbursed monetarily for providing such resources. Also, agents may access value-added services—information and so forth—provided by other agents, which could also expect payment in return. For example, in a marketplace, users can send agents to conduct purchases on their behalf. Thus, mechanisms are needed so that an agent can carry digital cash and use it to pay for resources used by it. Operating system-level support may be needed for metering of resource usage, such as the CPU time used by an agent or the amount of disk space needed during its visit.

Agent Monitoring and Control

An agent's parent application may need to monitor the agent's status while it executes on a remote host. If exceptions or errors occur during the agent's execution, the application may need to terminate the agent. This involves tracking the current location of the agent and requesting its host server to kill it.

Similarly, the agent owner may simply recall its agent back to its home site and allow it to continue executing there. This is equivalent to forcing the agent to execute a migrate call to its home site. The owner can use an event mechanism to signal the agent or raise an exception remotely. The agent's event/exception handler can respond by migrating home. This capability of remotely terminating and recalling agents raises security issues—only an agent's owner should have the authority to terminate it. Thus, some authentication functions need to be built into these primitives; that is, the system must ensure that the entity attempting to control the agent is indeed its owner, or has been authorized by the owner to do so.

Comparative Study of E-Commerce Requirements, Aglets, and HP Web Services

Finally, a set of e-commerce requirements will be defined to analyse Aglets' and HP Web Services' capabilities to fulfill them. The e-commerce requirements range from simple information exchange and bulk data transfer to secure firewall traversal, close collaboration and dynamic relationship requirements. It will be shown where each technology has its advantages and domains. This comparison also shows how the combination of both technologies can provide combined advantages and strengths.

Information Exchange in E-Commerce, Aglets, and HP Web Services

Many of today's e-commerce applications include complex business processes with a large number of concurrent tasks. These tasks may persist for a long duration; they may require long waiting times and could be nested within other tasks. Additionally, they are highly asynchronous, expose continues changes and may configure on the fly.

Thus, any flat conversation management, like message exchange, lacks the scalability for handling and tracking such sizable applications. Unfortunately, message exchange is the way Aglets interact. These messages always follow the same basic scheme. They are composed of a "message type" in form of a string and a "message content", which can be any type of object. However, they do not support the demands of modern e-commerce.

Any more complex transactions in Aglets are usually implemented through a centralized scheduling architecture, where one Aglet host serves a coordination unit and does the scheduling, monitoring and execution control. This may work well within one single enterprise, but causes serious problems for inter-enterprise transactions.

HP Web Services, on the other hand, evolved from the Distributed Computing paradigm, which is primarily involved in handling such transactions. The e-brokering system was added on top of that, and it closely follows the e-commerce model. Business tasks are modeled as services and can be composed through other lower-level nested services. A typical complex HP Web Services request is broken down into simpler requests. The set of service providers for each of these simple requests is then dynamically discovered. Subsequently, the best match is invoked, and its execution mediated. This model used by HP Web Services fits exactly into the demands of e-commerce.

Bulk Data Transfer in E-Commerce, Aglets, and HP Web Services

As personalized, continuously running and semi-autonomous entities, Aglets can be used to mediate users and servers to automate a number of time-consuming tasks in e-commerce. However, again, Aglets communicate via message exchange, which may not be suitable for bulk data exchange. Routing and caching a large amount of data imposes a considerable burden for Aglets. For example, moving data between an operational database and a data warehouse via an Aglet is very unlikely.

HP Web Services can provide asynchronous and synchronous communication in the same environment. Bulk data transfer is an easy task for HP Web Services, as well as for other distributed computing environments, like CORBA and RMI. It fits closely into distributed computing and is a direct extension from Networking Transport Protocols (like TCP/IP).

Extensible Mark-up Language (XML) as Joint Communication Language in Aglets and HP Web Services

In today's technical world, many different domain specific ontologies (Hewlett Packard, 2000e) are used. Ontology refers to the common vocabulary and agreed semantics specific for a subject domain. Both HP Web Services and Aglets mainly focus on establishment of collaboration, mediation and providing services. They thereby aim at generic solutions to be applied across many different sectors of businesses. However, a banking institution may use an entirely different ontology than a CD retailer.

Currently, XML is in the process of solving this problem. Through the use of Document Type Definition (DTD), each sector can create its own semantic that fits individual needs and yet remains generally usable across sector boundaries. The power of XML and its role in e-commerce have been widely recognized. Consequently, HP Web Services provides support for XML in its Application Programming Interface (API).

The software developed during this project enables communication between Aglets and HP Web Services. The software can receive and send Aglet messages as well as deploy HP Web Services. And it exports all these functionalities in the form of handy modules, to be configured together to fit individual needs. Furthermore, reuse was one of the major design considerations for this project. The software could be easily extended with additional modules to implement a proxy between the Aglet world, HP Web Services and the Internet. A DTD-based interpreter should closely fulfill these requirements. This would enable document-driven Aglet cooperation. Moreover, it would allow Aglets to share ontology (Hewlett Packard, 2000e) for multiple or even dynamic domains. In this way, the cooperation of dynamic Aglets would support *plug-and-play commerce*—mediating businesses that are built on one another's service. Aglets would acquire some of the key functionalities of HP Web Services.

Firewalls in Aglets and HP Web Services

Internet-based e-commerce involves multiple enterprises separated by firewalls. *Intra-enterprise* process management differs from *inter-enterprise* process management significantly. Different enterprises are not only separated by firewalls, but also have self-interests and individual data sharing scopes. When they are involved in a business process, they are unlikely to trust and rely on a centralized workflow server. Rather, they need support for peer-to-peer interactions. This has become the major impendence for using the conventional centralized workflow systems for inter-enterprise e-commerce automation.

One difficulty for the Aglet technology to fit into this picture consists in the limitation of its coordination model. HP Web Services, on the other hand, has Firewall Traversal as one of its standard services. Since HP Web Services has its roots in distributed operating systems research, it also has an integrated support for fine-grained access control. The HP Web Services Engine can be inserted at multiple points in the chain between clients and remote services. These remote services will act and look just like a local service, since the HP Web Services Engine acts like a kernel. Thus, the administrator can see and control access to services inside his network and firewall traversal is supported.

Collaboration in E-Commerce, Aglets and HP Web Services

An e-commerce scenario typically involves the following activities: identifying requirements, brokering products, brokering vendors, negotiating deals, or making purchase and payment transactions. Today, these activities are initiated and executed by humans.

Using Aglets or, in general, Mobile Agents technology, to support e-commerce automation is a promising direction. Aglets could be personalized, continuously running and semi-autonomous, driven by a set of beliefs, desires and intentions (BDI). They could be used to *mediate* users and servers to automate a number of the most time-consuming tasks in e-commerce with enhanced parallelism.

HP Web Services was primarily designed for enabling the creation of dynamic, Internet-based business relationships through the ad hoc discovery and interaction of e-services. E-services include applications, computing resources, business processes and information, delivered securely over the Internet. The HP Web Services Framework Specification (SFS) defines standard business interactions and conventions as XML documents that allow e-services to dynamically discover and negotiate with each other and compose themselves into more complex services.

Dynamics in E-Commerce, Aglets and HP Web Services

E-commerce applications operate in a distributed computing environment, involving multiple parties with dynamic availability and a large number of heterogeneous information sources with evolving contents. Dynamic relationships among a large number of autonomous service requesters, brokers and providers is common. A business partnership (e.g., between suppliers, resellers, brokers and customers) is often created dynamically and maintained only for the required duration, such as a single transaction. E-commerce activities typically rely on distributed and autonomous tasks for dealing with such operational dynamics. Thus, e-commerce is a *plug-and-play* environment. Services need to be provided on demand. To support such dynamics, an e-commerce infrastructure must support the cooperation of loosely coupled e-business systems.

Aglets with predefined functions but without the ability to modify their behavior dynamically may be too limited for mediating e-commerce applications properly. They cannot switch roles or adjust their behavior to participate in dynamically formed partnerships. For Aglets to participate in such relationships, a complex and sophisticated *dynamic behavior modification* infrastructure has to be developed on top of the standard Aglet services.

Turning Aglet cooperation from conversation level to process level could be a solution. In general, businesses collaborate following certain rules, such as, "if you send me a price request then I will send you a quote"; and "if the quote I sent you is acceptable, then you will send me an order." These rules include sequences of steps to form a business process. Such business collaboration usually involves multiple Aglets, each responsible for managing or performing certain tasks that contribute to the process. Adding inter-enterprise cooperative process management capability into agent-based systems is critical for these business collaborations.

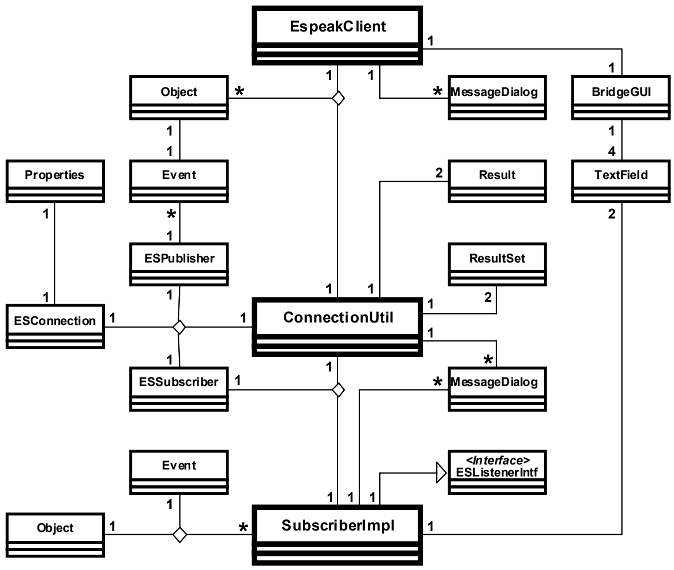
HP Web Services started from the beginning with the vision of dynamic brokering. Again, SFS allows e-services to dynamically discover and negotiate with each other and compose themselves into more complex services. This creates an open-service model, allowing all kinds of digital functionality to be delivered through a common set of APIs. SFS presents a uniform service abstraction and mediated access. New service types and semantics can be dynamically modeled using the common service representation of an HP Web Services resource. However, that requires all parties to comply with HP Web Services' service representation.

Architecture of the Cross-Platform Bridge

As already mentioned, the whole software system exports utility methods for collaboration between HP Web Services' and Aglets' applications. All functionalities can be accessed independently and are designed in a highly modular way. The important implication of the bridge is that it provides a means for mobile agent applications to port from one platform to another, thus enlarging potential applications.

The whole software can be partitioned into three subsystems, each operating in different environments:

Figure 1. HP Web Services client class diagram



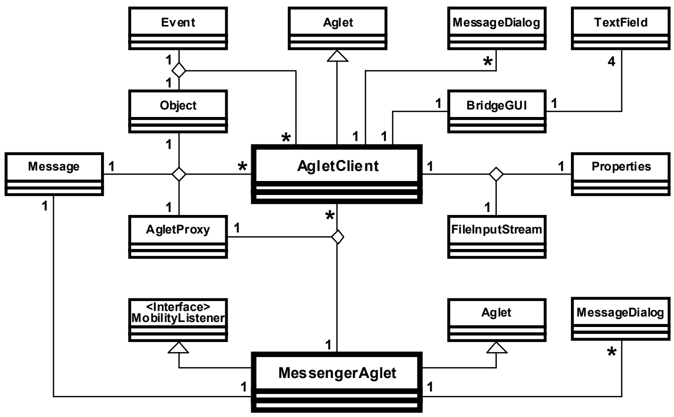
HP Web Services Client Software

The HP Web Services Client subsystem operates in a pure HP Web Services environment. Only the standard HP Web Services components and configurations are needed in the same way, as they are required for HP Web Services legacy applications. The environment includes a Client HP Web Services Core, where the HP Web Services Client software connects to and runs on top of it. The main purpose of this system is to provide access for external HP Web Services legacy applications to the collaboration functionalities provided by the Bridge Manager system.

Aglet Client Software

The Aglet Client software is the Aglet-side correspondent to the HP Web Services Client software. It operates from inside a Client Tahiti Server and exports a graphical user interface, as well as software interfaces to Aglet legacy applications. Again, only minimal Aglet configuration is required. This system mainly serves as a gateway for Aglets to deploy the Bridge Manager's collaboration services, similarly as the HP Web Services Client software does for HP Web Services.

Figure 2. Aglet client class diagram



Bridge Manager System

The Bridge Manager consists of both a Bridge HP Web Services Core and Bridge Tahiti Server. This combined unit allows collaboration between any HP Web Services and Aglet environment. The operating system hosting this entity needs to have both the configuration required for the HP Web Services environment and the configuration required for the Tahiti Server and Aglets environment. The HP Web Services side of the Bridge Manager mainly handles intercommunication and collaboration with HP Web Services legacy applications, whereas the Tahiti Server side attends to Aglets legacy applications.

There can be many instances of HP Web Services Client systems and Aglet Client systems. Their number is mainly limited by hardware resources and network conditions. Additionally, there can also be many instances of Bridge Manager systems. They can be hosted on the same physical machine or in a distributed environment. Collaboration between all those entities will still be maintained, and they can form different communities of collaboration. Multiple memberships in different communities are also possible as dynamic entries and leaves.

Design Principles for the Bridge between Aglets and HP Web Services

The following sections elaborate on methodologies and general design principles that have to be deployed throughout the course of the design. These mainly describe

Figure 3. Bridge manager class diagram

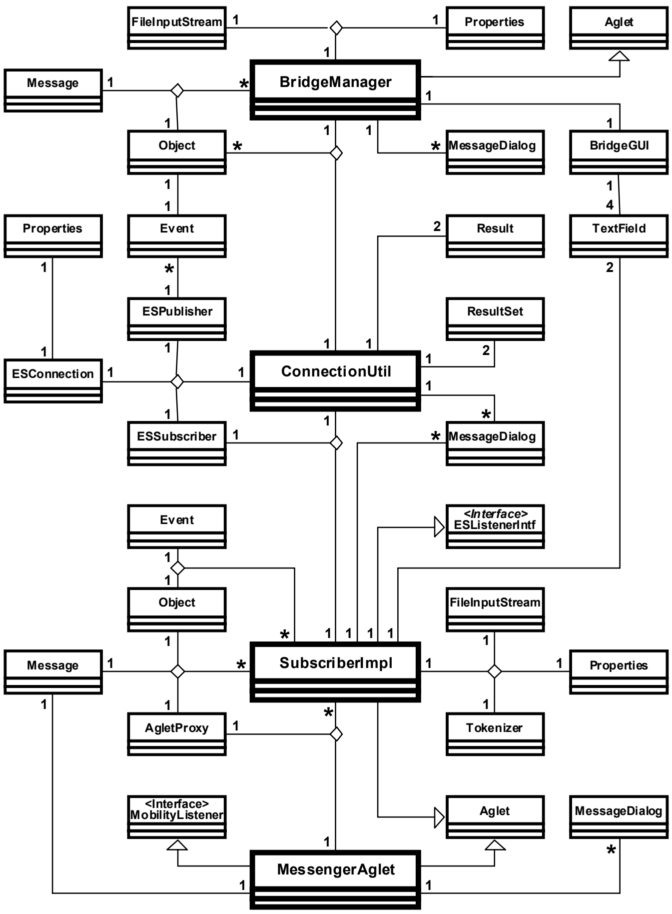
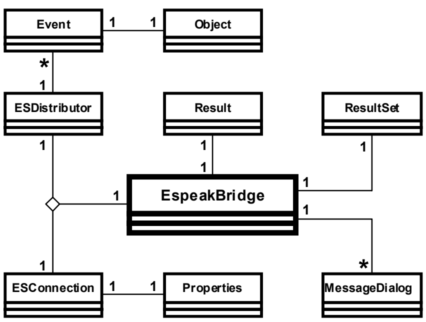


Figure 4. Event distributor class diagram



fundamental design techniques necessary for developing HP Web Services software as well as Aglet software.

Choosing the HP Web Services Interface

Two interface options are available with HP Web Services:

J-ESI

This interface to HP Web Services is based on Java and allows interaction with the HP Web Services core or HP Web Services through APIs (Dantas et al., 2002).

WebAccess

This interface to HP Web Services is based on XML and enables interaction with the HP Web Services core or HP Web Services through standard Web browsers by returning HTML or XML documents (Glitho, Olougouna, & Pierre, 2002).

The Java model is oriented towards traditional API interfaces. Services are described by having an API or set of APIs. The client can make calls to discover services, retrieve a stub object and then invoke the services. These are typically synchronous methods, with calls to methods producing results, which the client will wait on.

The XML model, on the other hand, is a fundamentally asynchronous, document-based interface. Services are described not by a set of APIs but by a schema, which describes a set of XML documents that those services can understand. To find a service, a document defining the query for services is sent to WebAccess, which will then return a document describing these services, which fit the query criteria.

Computational Services

Computational services fit well with the API-style (Java) model. For instance, the contributed service of the Virtual File System is based on the Java model and exposes a core set of functional methods (Read, Write, Open, Close), which can be invoked by a client.

The API model typically assumes knowledge of the exact interface at programming time; usually through importing the Interface Definition Language (IDL) definitions at compile time to generate the stubs needed. This means that the interface must remain unchanged though the life of that version of the client. If the interface changes or is extended, the clients must be recompiled to handle or take advantage of the changes.

Business Services

Informational-, business- or broker-type services fit well with the document mode.

The client can discover changes or extensions in the document model when he or she downloads the schema (DTD). On one hand, the document model requires some additional effort in parsing the schema and handling different formats for documents; but on the other hand, this allows greater flexibility for the client software, since it is possible to handle a wider range of changes with recompiling.

Overview of Creating E-Services

The procedure of building and deploying an e-service with J-ESI (Dantas et al., 2002) involves three main steps:

- Specification of the contract (interface) for the service.
- Writing the implementation code for the interface.
- Deploying the service.

One of the first steps is to create the contracts (interfaces) for the services. E-services can be built with any programming language, but the interfaces used with J-ESI (Java HP Web Services Interface (Java-API)) have to conform to the HP Web Services IDL. The development stage involves writing the implementations for the interface. To accelerate development time, one may choose to deploy existing services (HP Web Services's standard services or third-party e-services) as components or convert legacy applications into e-services.

The next step is to specify relevant attributes and use the vocabulary service provided by the HP Web Services engine to describe the e-service. The e-services are registered through HP Web Services elements that are connected to a service engine and can be discovered across multiple groups of HP Web Services Cores within a community. Interactions between e-services are mediated by the HP Web Services infrastructure.

The Service Contract

This service contract (interface) is defined as an HP Web Services IDL, which is similar to the Java-RMI IDL and must have a ".esidl" extension for the IDL compiler to recognize it as an HP Web Services IDL file. It would have the following structure:

```
public interface SomeServiceIntf {
   public <returnType> firstMethod (<type> inParam, ...);
   public <returnType> secondMethod (<type> inParam, ...);
}
```

The IDL file needs to be compiled using the HP Web Services IDL compiler:

```
java  net.espeak.util.esidl.IDLCompiler
SomeServiceIntf.esidl.
```

The IDL compiler generates the following files, which are used by J-ESI (Dantas et al., 2002):

```
SomeServiceIntf.java
SomeServiceStub.java
SomeServiceIntfMessageRegistry.java
```

The file SomeServiceIntf.java is a copy of SomeServiceIntf.esidl, with minor changes to make it an HP Web Services interface. SomeServiceStub.java is the stub class that the service finder returns to the client when it discovers the look-up service. For every method defined in the interface, the stub class contains the code to create messages, marshal parameters and send it to the service provider. The SomeServiceIntfMessageRegistry.java is used by J-ESI to register the object types.

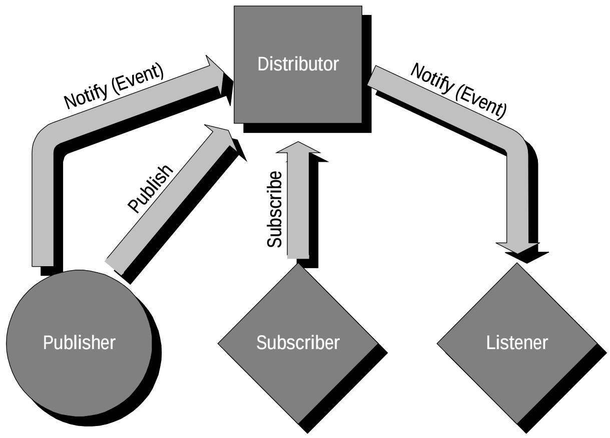
As mentioned in the previous chapter, one may choose to accelerate development by making use of HP Web Services build-in features. The J-ESI interface already provides functionalities to implement the publisher subscriber model. For this particular problem of collaboration utility methods, the authors' recommendation is to deploy J-ESI's net.espeak.jesi.event.ESListenerIntf class.

The next section describes the design details of HP Web Services's Event Service, an extensible service targeted at loosely coupled, distributed applications. Events provide a publish-subscribe mechanism for communication built on top of HP Web Services messaging.

The Event Model

HP Web Services supports an extended form of the familiar publisher-subscriber event model. There are four logical entities in the HP Web Services Event Model, whose interactions are illustrated in Figure 5. These entities are Publisher, Listener, Distributor and Subscriber.

Figure 5. HP Web Services Event Model



A Publisher is an entity that generates an Event notification message. The recipient of an Event notification is called a Listener. A Distributor is an extension of a Listener. It receives Events and forwards them to other Listeners. A Subscriber is an entity that registers interest in a particular Event with a Distributor and designates the Listener to whom Events are sent. The Subscriber and Listener are typically the same physical entity. Similarly, it is fairly typical for a Publisher to act as a Distributor of its own Events.

In J-ESI (Dantas et al., 2002) these entities have the following representation:

- Event: net.espeak.infra.cci.events.Event
- Distributor: net.espeak.jesi.event.ESDistributor
- Listener: net.espeak.jesi.event.ESListenerIntf
- Publisher: net.espeak.jesi.event.ESPublisher
- Subscriber: net.espeak.jesi.event.ESSubscriber

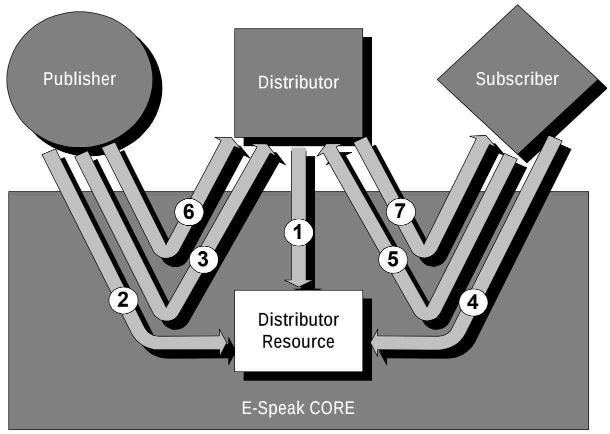
The Core itself is an example of an Event Publisher. It sends Events to a trusted Client, called the Core Distributor, to signal state changes, such as a change in a Service's attributes. The Core Distributor may then distribute these Events to interested Clients that have appropriate authority.

Figure 6 illustrates a typical Event notification process where the Subscriber and Listener have been folded into a single Client.

The following numbers in the figure represent these steps in the process:

1. The Distributor registers with the Core.
2. The Publisher discovers the Distributor.

Figure 6. HP Web Services Event notification process



3. The Publisher sends a Publish request to the Distributor describing the Events it will be generating.
4. The Subscriber discovers the Distributor.
5. The Subscriber sends a Subscribe request to a Distributor, describing the Events in which it is interested.
6. The Publisher sends the Event to the Distributor using a notify message.
7. The Distributor forwards the Event to the Subscriber (also using a notify request).

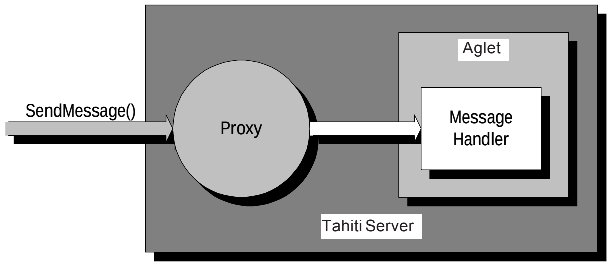
Communication in Aglets

The principal way for Aglets to communicate is by message passing. Inter-Aglet messaging is based on a simple event scheme that requires an Aglet to implement handlers for the kinds of messages it is supposed to understand. These *"kinds of messages"* in Aglets are the direct correspondent to the *"event types"* in HP Web Services. The message-handling method is not directly called to send a message to an Aglet. Instead, a 'sendMessage' method on a proxy is invoked. This proxy serves as a message gateway for the Aglet. One of the benefits of using a proxy is that it provides a location-independent interface for sending messages to Aglets. In other words, it does not matter whether a remote proxy (a proxy on a remote Aglet) or a local proxy is used to send a message; the interface remains the same.

The 'sendMessage' method of the proxy takes a message object as an argument and sends the message to the Aglet for which the proxy is acting as a gateway. The method may return an object in reply to the message.

The 'handleMessage' method of the Aglet class is one of the key methods that one has to override. It enables the Aglet to respond to messages sent to it. Typically, the implementation of this method will consist of a switch statement that tests for the kind

Figure 7. Aglet message passing mechanism



of the incoming message. The handler is supposed to return a Boolean value, whether the message kind was understood and handled. Figure 7 illustrates the message passing mechanism in Aglets.

Messages in Aglets are objects. A message object is characterized by its *kind*. This property is used to distinguish messages from each other. The com.ibm.aglet.Message class supports a range of constructor that all have *kind* as a mandatory argument. Message objects also contain an optional argument field for data associated with a particular message. The argument field can be either atomic (String, int, etc.) or tabular (Hash table). The many message constructors represent shortcuts for the initialization of the argument field. After an Aglet message handler receives messages, it will determine the kind of messages and then retrieve a possible argument from the message.

The Message class also provides methods for handling non-atomic arguments. The reason is that messages often need to carry multiple arguments to the receivers. Such arguments are most effectively handled as key-value pairs. The "setArg" and "getArg" methods are convenient for organizing multiple arguments into a table. Another group of methods in the Message class enables direct replies to incoming messages. The message handler thereby uses the incoming message object to deliver a reply.

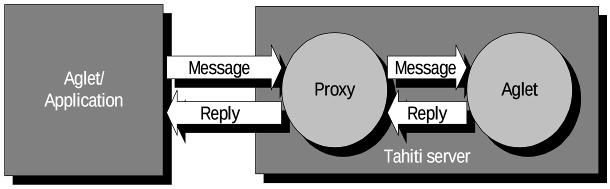
As mentioned in this chapter, the proxy object plays a fundamental role in Aglet messaging. The next chapter, therefore, will introduce the Aglet proxy and describe the rationale behind this element of the Aglet API.

Aglet Collaboration through Proxies

An Aglet is fundamentally a mobile event and message handler. Associated with each Aglet is a proxy object that serves several purposes. Two of its most important roles are (1) as a shield to avoid uncontrolled access to the Aglet's public methods, and (2) as a convenient handle for a local, remote or deactivated Aglet.

When an Aglet is created (AgletContext.createAglet()), it is automatically associated with a proxy object that is returned to the application. The application should then use this proxy to control the Aglet. Unless the Aglet gives away an object reference to itself,

Figure 8. Relationship between Aglet and proxy



it is impossible for the application or any other Aglet to access any of the public methods and fields in the Aglet.

It should never be necessary to operate directly on the Aglet itself. The application can control the Aglet through the proxy's methods: clone(), dispose(), dispatch(), deactivate() and activate().

The dispatch() method will return a new proxy that gives control of the remote Aglet. It is here that location transparency comes in. The proxy returned by the dispatch() is identical to the proxy to a local Aglet, but referred to as remote proxy. As a consequence of this architecture, an Aglet can have only one local proxy, but multiple remote proxies. Figure 8 shows the relationship between an Aglet and its proxy.

An Implementation Example

Context

Every organization is trying to do more with less. This is particularly true of today's highly competitive global business environment. Many organizations are starting to turn towards technology to advance their competitive edge.

Mobile agent technology is a logical step in the evolution of e-commerce. This software technology enables a paradigm shift for the Internet from a "do-it-yourself" model to a "do-it-for-me" model.

Agent technology promises to deliver cost effective Inernet-specific labor. At the low end, agents can roam the Internet while we sleep and present us with documents of interest first thing in the morning. More sophisticated Internet-based agents can perform statistical mapping to find those elusive documents, songs or movies. In the near future, they may represent us on the Internet, negotiating and purchasing things we want.

Objective

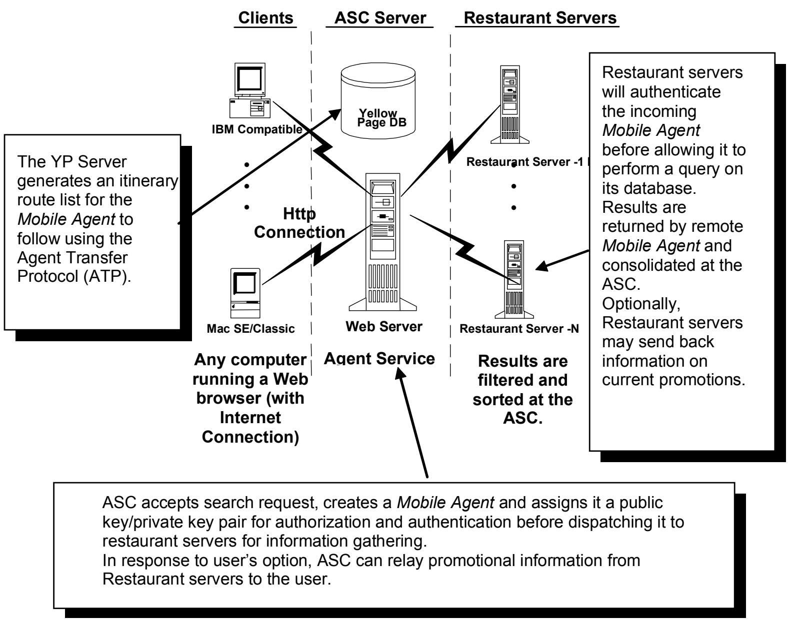
A project was started with the aim of building an intelligent software agent-based framework for Internet information gathering. A system for recommending local restaurants to hotel guests is built to demonstrate the framework. The intelligent software agent can automatically roam the Internet, gather the relevant information about some food and services from online restaurants and provide the most optimized selection as a suggestion to help the user make his decision. In addition, the restaurant servers can "push" promotional information to the customers. The system also provides security features to protect information and communications between the participating host servers.

An Overview of the System Structure

The mobile agent framework consists predominantly of Client, Agent Service Center (ASC) and the Restaurant Server Platform (Figure 9).

The hotel guest will be able to access the online restaurant recommendation system through a Web browser in his or her hotel room. The search request(s) made by the guest will be registered with the ASC. The ASC will then process each request and generate a list of online restaurant sites that will likely to provide the pertinent information (i.e., food dishes) requested by the guest. The Yellow Page (YP) server, which provides a

Figure 9. Architecture framework for online restaurant guide system



database of such online sites, helps to facilitate the compilation and generation of a list of such relevant online sites. This list of online sites will constitute the itinerary list that the Mobile Agent (MA) will have to visit. As mentioned, another main functionality of the ASC server would also be to generate a mobile agent that will begin traveling to the online restaurant sites to gather data on behalf of the user.

The mobile agent will abide by the generated itinerary list as it travels from one online restaurant server to another to complete its search for food and restaurant information. Upon arrival at each online site, the mobile agent will ask the restaurant server to search for the food based on the user's search requirements. In addition, the restaurant server can retrieve its promotional information and push it to the ASC server, which in turn displays the promotional information to the users.

Design Subsystems

The design subsystems are depicted in Figures 10 and 11.

ASC

The ASC subsystem accepts a search request from the Web Server and dispatches a Mobile Agent to Restaurant Servers for information gathering. The information gathered by the Mobile Agent will be consolidated at the ASC, which will then forward the findings to the Web Server and be displayed on the hotel guest's PC.

Within the Agent Service Subsystem exist the Agent Management subsystem and User Management subsystem, which provide the overall functionality of the parent subsystem. The Agent Management subsystem manages the creation of agents and provides search results to users. The User Management subsystem manages the creation of users (at the arrival of hotel guests) and maintains a user database.

YP Server

The YP Server provides a list of online restaurant servers where the Mobile Agent can be dispatched. It consists of a database that provides the route list.

Restaurant Server

The Restaurant Server is normally provided by each participating restaurant to host the Mobile Agents. The server provides all the information related to the search request submitted by the customer. The dispatched Mobile Agent from the ASC will roam the Restaurant Servers according to the order as inscribed on the route list.

Figure 10. Design subsystem

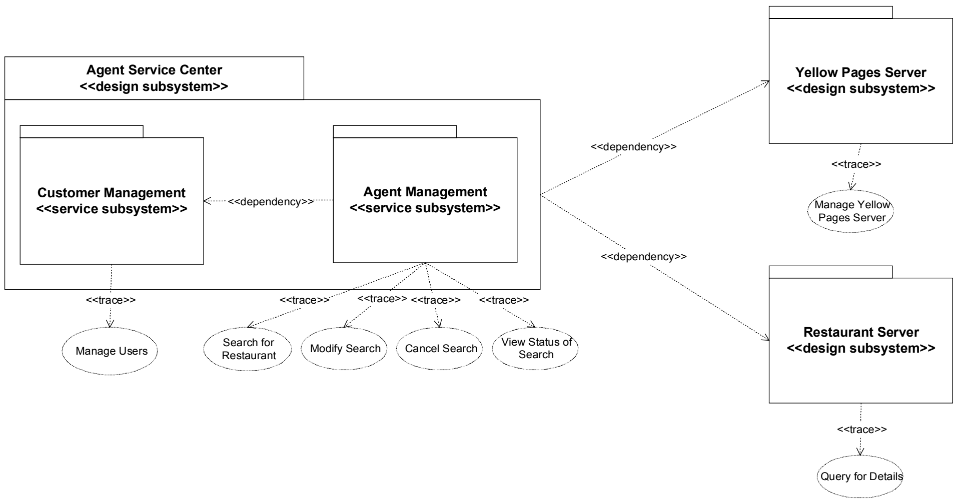
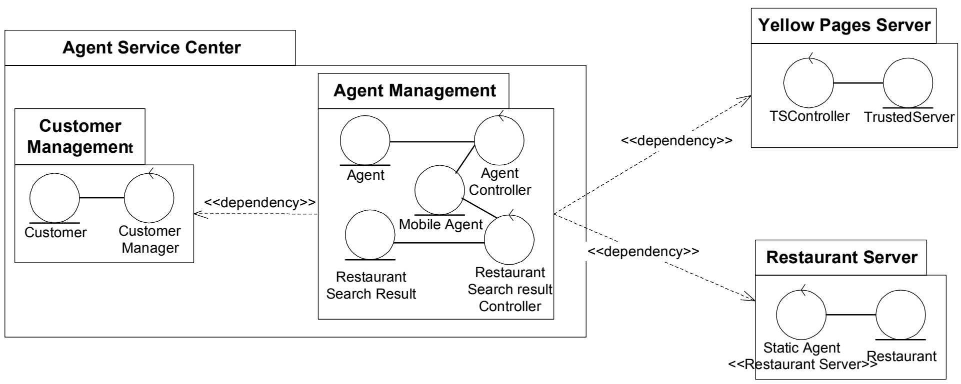


Figure 11. ASC



Key Services Identified

As a first version of the system, the following services have been identified.

Search for Restaurant

The user will select the "search for restaurant" option the main Web page. This will take him or her to a new Web page that will form the interface for specifying new search parameters. The user will be prompted to specify the search criteria. The system will generate a public/private key pair and route list for the newly created agent. The agent will then examine the route list and move to the first destination. The destination server will authenticate the mobile agent before allowing the parameters to be passed to the static local search agent. The search handler will start searching for stipulated requirements. The results will be filtered before passing them on to the mobile agent for return to update the search result database.

Modify Search

The user will select the "modify search for restaurant" option in the main Web page. This will take him or her to a new Web page that will form the interface for specifying new search parameters. The user will be prompted to specify the new search criteria. The Web page will pass this information to the ASC. The host will retract the existing mobile agent, following which, the system will generate a public/private key pair and a route list for a newly created agent. The agent will then examine the route list and move to the first destination.

Cancel Search

The user will select the "cancel search for restaurant" option in the main Web page. This will take him or her to a new Web page that will form the interface for canceling the search. The system will show a list of active user's agents. The user then chooses the agents to be canceled. The user will be prompted for confirmation of the cancellation. On confirmation from the user, the host will track the location of the selected agent and retract it.

View Status of Search

The user selects an agent from a list of mobile agents using the system Web page. Upon selecting an agent, the user views the search status of selected agent by invoking the "view search" option. The agent controller coordinates the get search status event by asking the static agent to get the search results from the restaurant search results database, which resides in the ASC server. The results will then be displayed on the user screen.

Main Parameters of the System

The basic aim of the system is to allow the customer to search for restaurants in town that have an Internet presence using the mobile agent system. To achieve this, the customer will provide the following pieces of information to the system:

- **Ambience:** User can specify “air-conditioned,” “non air-conditioned,” “pool side” and so forth.
- **Average Price Rating of Meals:** User can choose a rating on how much he or she is willing to pay for a meal.
- **Location:** User can specify the region in the country where he or she wishes to have the meal; for example, Orchard, Marina Bay, City Hall and so forth.
- **Restaurant Specialty:** Whether the user has preference for any particular kind of food; for example, Italian, Mexican, Continental, Chinese and so forth.
- **Name of Dish:** Specify the name of any particular dish the user is looking for. He or she can choose the dish based on a textual description provided. Photos images will be shown when available.

Based on these inputs from the user, the mobile agent will roam from one server to another (each server being hosted by a restaurant and providing information about the restaurant) looking for restaurants that match the user’s requirement. After the results are consolidated, they will be displayed on the user’s PC. If the number of results obtained from the search is large—for example, more than 20—the system will then inform the user that the search has led to many results and will give him or her the option of either seeing all of them or redefining the search criteria.

Flow of Events

The following describe the process a user of the system has to go through:

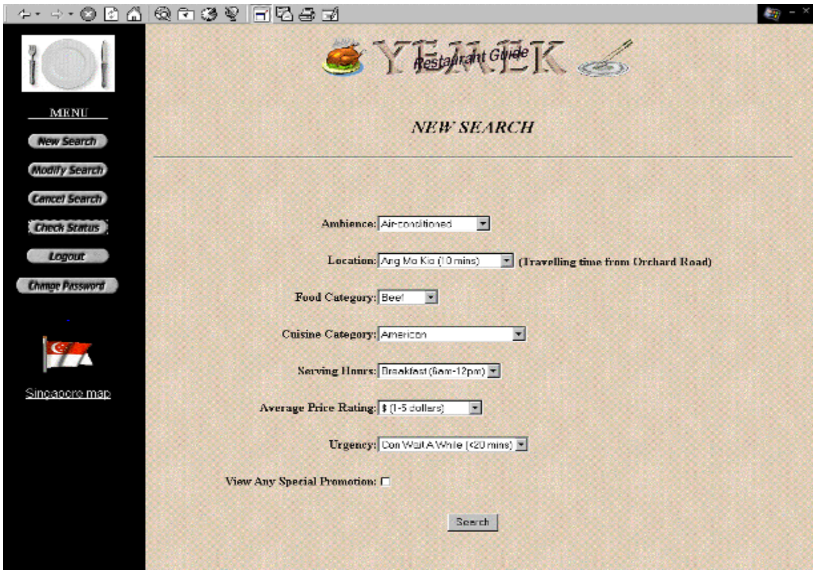
1. User has been authenticated by the system as he logs in.
2. User invokes the systems by entering the search information needed to aid the search for restaurants or food before a new mobile agent is created and sent into the network. Parameters that the user has to provide were described earlier.
3. A new search record is created in the agent-track list and a mobile agent is created and dispatched to the restaurant server to search for the required information.
4. The search result is retrieved by the mobile agent from the restaurant server and is returned to ASC for filtering and updating of the search results workspace. The mobile agent then moves on to the next server for information gathering.

4a. At times, certain restaurants may have some promotional dishes on offer. When the mobile agent visits those restaurant servers, it will leave the Internet address of its origin with the servers, so that the latter may send promotional information to the ASC.

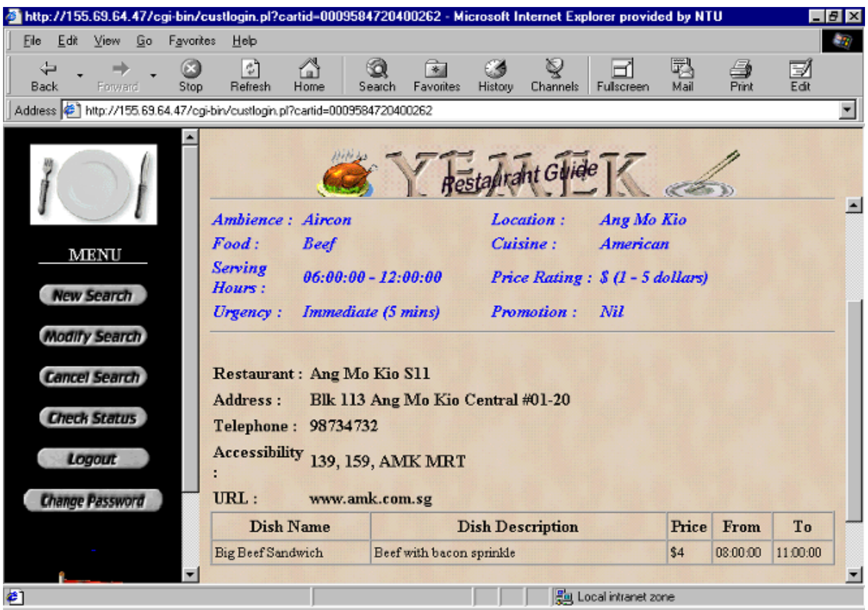
5. Once the mobile agent has visited the last restaurant server on its itinerary, it will signal its status to the ASC, which will then present the consolidated search results to the user.

Key User Interfaces of the System

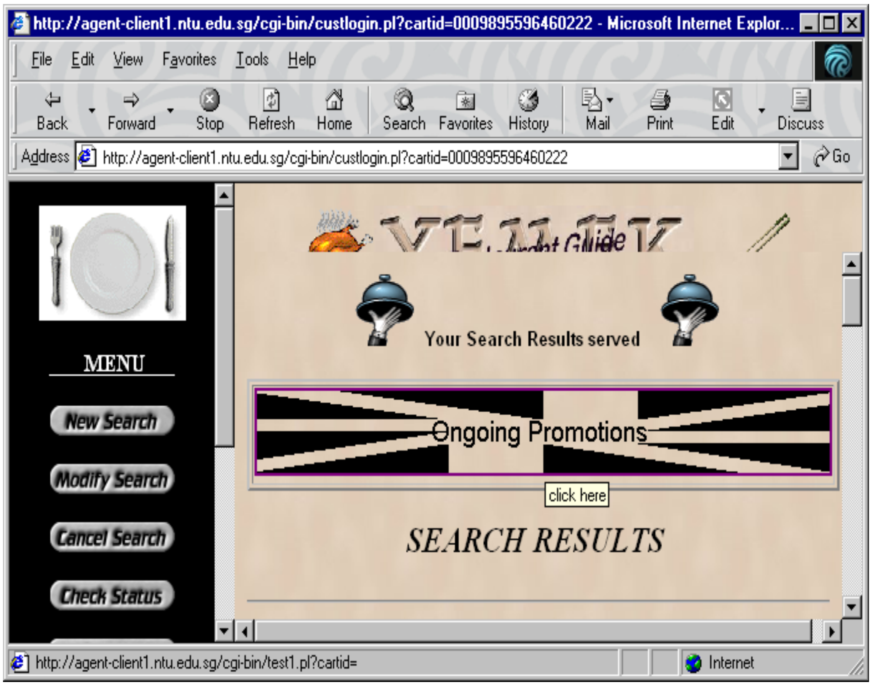
1. New search (creating new mobile agent)



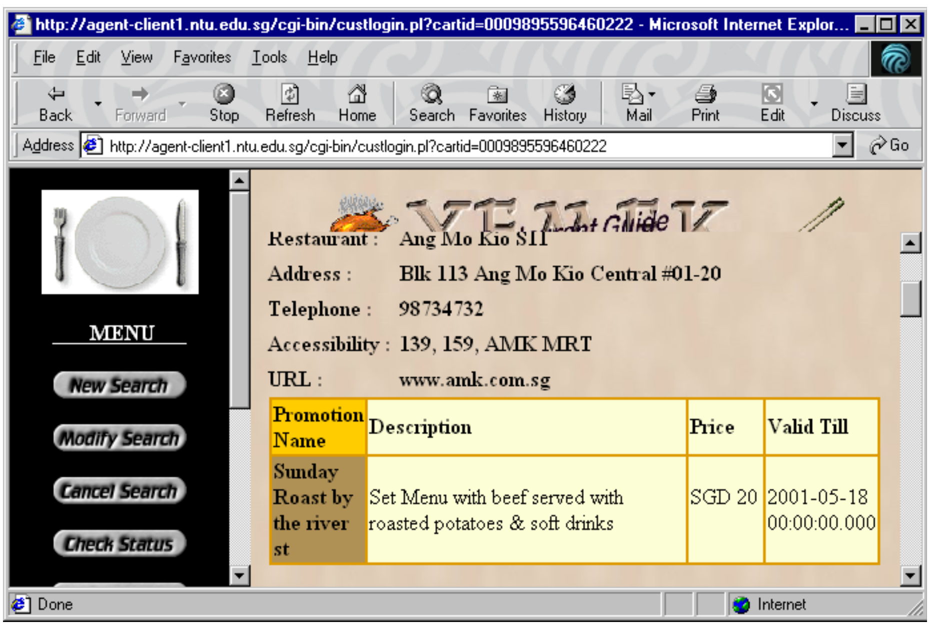
2. Displaying results of search request



3. Announcing the availability of special promotional dishes



4. Displaying details of promotional dishes



Summary of System Features

A mobile agent system has been developed to perform a restaurant food search for customers from restaurants with a Web presence. Also, details on promotional offers are also "pushed" to the user. While not described in this chapter, the security of the system and integrity of the data are ensured by means of cryptography and digital signature schemes. The system provides a user-friendly environment for easy usage.

Future Enhancements

Besides fine-tuning the system to run in both Aglets and HP Web Services environments, we are also working on the following areas: We are extending the ASC functions to handle reservation requests from the user. This will require further mobile agent activity such that the mobile agent will interact with the restaurant reservation system to place a booking. This will naturally involve payment options that must be provided for the user to pay for his meals. To push the technology further, we also are exploring the possibility of allowing autonomous negotiation by the mobile agent. Basically, mobile agents representing the users and the restaurant servers will meet at some cyberspace negotiation room to transact their requests for the respective hosts they are representing (Quah & Goh, 2002).

Conclusion

The above sections and application example have demonstrated the feasibility of creating a bridge to link Aglet and HP Web Services into a virtually common platform for recreating mobile agent applications. Such a mobile agent-based e-commerce system can indeed offer competitive advantages to businesses and help manage information flows to strategically link enterprises. Main advantages achieved through such a system are:

1. Lower cost of operation. This is mainly achieved through autonomous processes of the mobile agents.
2. Efficient supply-chain management. In the application example, hotels and restaurants have achieved a win-win collaboration through linking their services into a seamless system that provides added value for their common customers—hotel guests.
3. Conveniences to customers. This will likely increase patronage and thus improve revenue in-flow and enlarge market share.

In conclusion, it can be envisaged that the future of multi-platforms mobile agent-based systems is bright, and the number of potential applications is enormous. Such systems are likely to bring forth competitive advantages to business enterprises.

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Chapter X

Applying Directory Services to Enhance Identification, Authentication, and Authorization for B2B Applications

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Abstract

System-to-system integration is an essential aspect of Business-to-Business (B2B) organizations. This chapter proposes a common infrastructure model for B2B applications, referred to as the IAAIBB model. It aims to centralize the Identification, Authentication and Authorization (IAA) infrastructures and to provide easy interoperability among business partners. The key technique is to incorporate the directory service into business applications. The directory service acts as the core repository of the IAAIBB model to support all functions associated with identification, *authentication and authorization. The chapter illustrates how IAAIBB enables a sound trust relationship for B2B applications, as well as the implementation of the IAAIBB model. Also reported is the evaluation of the IAAIBB model, which reveals a number of advantages. The IAAIBB model leverages on the strength of XML, the directory service, the PKI cryptography and role-based access control.*

Introduction

Business entities face tough challenges nowadays. Companies are pressured to reduce costs and work with fewer resources, while at the same time develop marketing campaigns that hit the market faster, generate better leads, drive higher revenues and increase customer retention rates. It is widely accepted that business automation and integration would be a solution to meet these challenges. As observed by Olsen (2000), system-to-system integration is an essential aspect of the B2B segment that brings company internal business applications over the Internet, while interfacing with business partners electronically.

Advanced companies are going beyond simply specifying software architectures and creating a *business model* that provides a framework for all corporate applications. For example, unified modeling language (UML) is widely used for such modeling purposes (Li, Cao, Castro-Lacouture, & Skibniewski, 2003). Nevertheless, trust and interactivity are critical success factors throughout any business process (Wilson & Abel, 2002). A good B2B relationship implies that both organizational and personal needs should be addressed coherently (Tellefsen, 2002). This issue should be addressed as early as at the system definition and design phase. A directory service, which is tightly bound to a company's and its suppliers' structures, would be employed, for example, to address a purchasing manager's personal needs for dealing with various users by varying sense of control.

Related Work

Konstantopoulos, Spyrou and Darzentas (2001) pointed out that efforts should be given to the development of standard infrastructures for deploying directories and the use of public key infrastructure (PKI). B2Bexchange.com developed a hub-and-spoke concept to enable numerous communication protocols to be "translated" at the central exchange hub without overloading the end system at the company side. Oracle proposed a B2B integration technology architecture that consists of two repositories for interactions with pre-defined business processes (Bussler, 2002). IBM developed a conversation model providing conversation policy-based support, which performs as an exchange "glue" to handle message-centric B2B interactions (Hanson, Nandi, & Kumaran, 2002).

RosettaNet has been widely recognized as a B2B process standard in addition to B2B data standards (Lewis, 2000), but it focuses exclusively on the public business processes. Built upon the OSI 7 layer standard, all RosettaNet standards are at the application layer, and thus their extensibility is limited. By comparing different types of commercial business applications, Chen (2003) suggested that "using *standards* to facilitate the communications between two different systems is the most promising approach to facilitating e-business integration." Popular standard-related technologies for e-business systems include HTTP, XML, SOAP, WSDL, UDDI and PKI (Sheldon, Jerath, & Pilskalns, 2002). Electronic Data Interchange (EDI) is a set of standards for controlling the transfer of business documents, such as purchase orders and invoices, between computers. But it is too costly, complex and rigid for small and medium enterprises (SMEs) to take advantage of it (Stefansson, 2002).

It is reported that XML greatly impacts business applications, such as integrating ERP packages, communications, database systems, standards, as well as security (David, Shi, & Cheng, 2002). Li et al. (2003) proposed an "e-union" model using XML to improve the interoperability. The model first converts database tables into XML documents, then uses them as a standard data-exchange format. It is difficult, however, to support customized XML standards for specific industrial sectors.

Online B2B transactions involve four important issues: data confidentiality, authentication, non-repudiation and integrity (Engel, 2001). Technology-wise, PKI can be used to meet these requirements. PKI has potential for supporting multiple applications. To achieve this, this chapter introduces the directory service technique.

For an efficient integration of business applications, organization should define the objectives (i.e., roles) clearly, and ensure the decentralization of decisions according to responsibilities (i.e., assigning roles to individuals properly) (Doumeingts, Ducq & Kleinhans, 2000). A directory service can be used for storing management information, such as rules and company policies. Then, role-based access control (RBAC) can be enabled to facilitate the management of access control lists (ACLs) with more flexibility and reduced workload of IT staff (Sandhu, Coyne, Feinstein, & Youman, 1996; Songwan, Gail, & Joon, 2002).

Although a few ubiquitous B2B architectures exist, there is rarely a common infrastructure for running business applications (Lewis, 2000). Software components such as "glue" or agent and enterprise application integration (EAI) are commonly used nowadays to enhance those applications with information exchange (www.B2Bexchange.com). The need for extra data manipulation not only reveals security threats, but also increases the error rate.

With the increasing adoption of B2B applications, more and more pairs of user IDs and passwords need to be managed. Much time and effort have to be devoted to user identification and authorization, which is not value-added at all. It is imperative in the first place to minimize the number of logins for end-users. The prerequisite for this is to find a reliable and unified mechanism for end-users to identify and authenticate themselves.

X.500 was defined as a completed directory service to operate over an ISO/OSI network (CCITT, 1988). However, X.500 does not support TCP/IP, and its specification is too complex for commercial applications. A simplified version of access-protocol for X.500 was introduced in 1997 and approved by the Internet Engineering Task Force (IETF) as a lightweight directory access protocol (LDAP) (UoM, 2002). Jamhour (2001) pointed out that the LDAP is a lighter version of X.500, which is a bit misleading.

Interoperability among directories requires common object schemas and understandable communication protocols. LDAP is the well-known directory accessing protocol and is widely supported by commercial software vendors; directory service markup language (DSML) is an emerging, effective high-level protocol to access directories (Songwan et al., 2002; OASIS, 2002).

In a directory service-enabled distributed data-provisioning environment, end-users may have problems with where to find the data (location) and how to get the data (query mechanisms). Marquina, Ramos, and Taddei (1998) developed a metadata advertising protocol to deal with these problems. Similar to XML, their proposed mechanism establishes user data descriptions to avoid predefining strict data regulations. However, this is impossible nowadays, in a heterogeneous network environment. Since XML has emerged to become a de facto standard for data exchange over the Internet, the adoption of XML would hopefully help keep the system more open.

Both LDAP and XML have been used as the communication protocols for directory services. Kuz (2002) uses LDAP as the communication protocol for GIDS. Some people proposed to use SSL and PKI as a means to ensure the confidentiality for transmitting data. LDAPS (www.ldaps.net) is a refined version of LDAP that caters to security needs. Hash algorithm is also used to safeguard directory service nodes' credentials (Berger, 1998).

Strategy for Solution

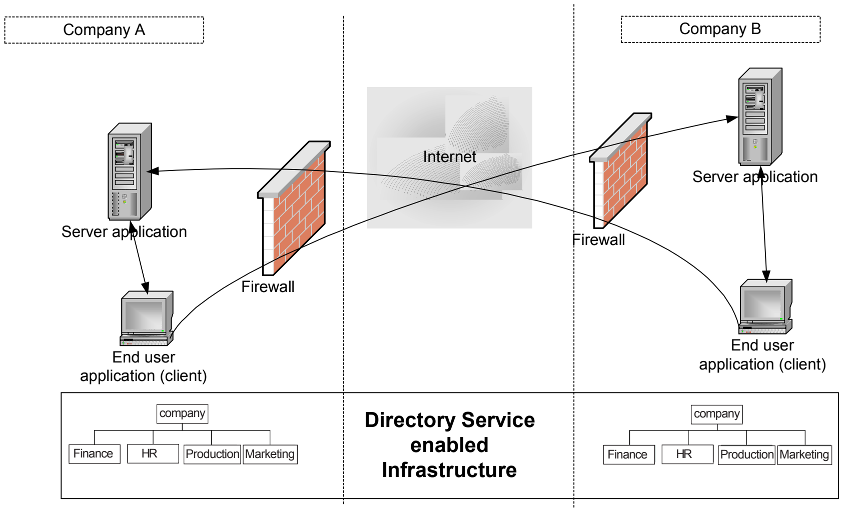
Current work on directory service mostly focuses on intra-organizational applications, but rarely on B2B integration. While European researchers have contributed substantially to data exchange, security and enterprise modeling, a very limited number of papers deal with the integration of directory services with business applications. The application of directory services to the identification, authentication and authorization infrastructures is yet to come.

This chapter proposes a directory service-enabled infrastructure model for B2B applications (referred to as IAAIBB model) for centralizing the identification, authentication and authorization infrastructures. It aims to provide a smooth interoperability among business partners. The key technique is incorporating directory services into business applications. The directory service acts as the core repository of the infrastructure model to support all functions related to identification, authentication and authorization. In addition, it should be platform independent, open, extensible and secure. The IAAIBB model leverages on the advantages of XML, directory services, the PKI cryptography and RBAC.

Overview of IAAIBB Model

The IAAIBB model employs the directory service as its supporting infrastructure. The working principle of the IAAIBB model is illustrated in Figure 1. The model reduces end-

Figure1. The IAAIBB model in view of connectivity



users' login times to one for all applications. It also simplifies system connections and lessens the number of high-level application servers. With reference to the layered network model, the interactions within the IAAIBB model are demonstrated in Figure 2.

This model consists of two major components: the directory service, and the IAA layer, which talks to the directory service. The directory service holds user information and critical business rules, and deals with data fusion. Adapted from conventional network reference models, the IAA layer seeded in every computer is an executant that guarantees the business rules be followed strictly. The IAA layer may query a business partner's directory services for authenticating a remote user.

This model provides a single management interface for a user to sign on. Managers do not have to bother IT staff to enable access in ubiquitous systems, nor is it necessary for end-users to remember many ID and password pairs. Data encryption and advanced user authentication mechanics are built in the model, thus contributing to the robustness of B2B application systems.

Directory Service

A directory service is the core technology that supports IAA layer and provides essential security information. It is not an internal component of the IAA layer, but a relatively standalone computer system. Separation of these two parts helps make the system neat and flexible, as different companies may use different directory services.

Figure 2. The IAAIBB model

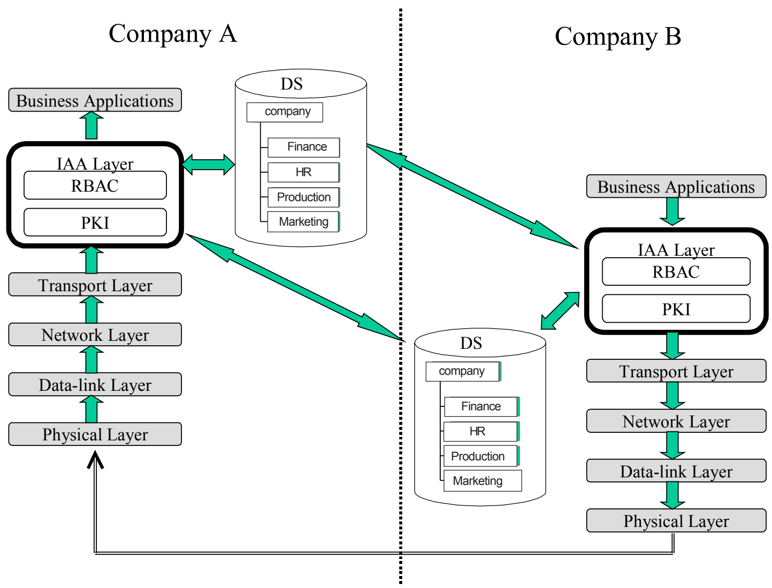
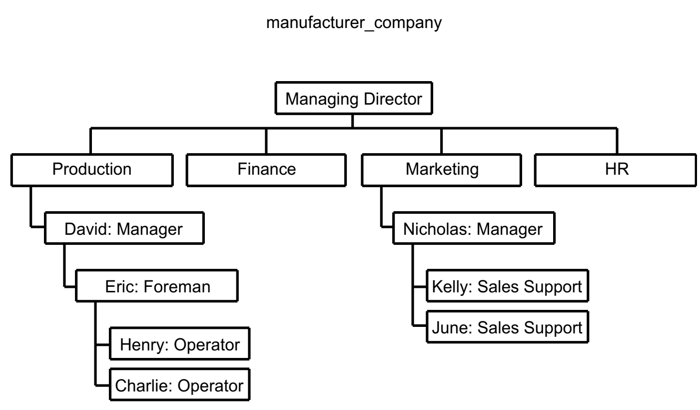


Figure 3. Organizational chart of "manufacturer_company"



Mapping organizational structure in computer. Assume a company is named "manufacturer_company." For illustrative simplicity, only the production and sales departments are expanded. A typical organizational chart is shown in Figure 3.

This organizational structure is then mapped into a computerized directory service, as shown in Figure 4, where the Novell Netware NDS console is used for demonstration. There are four important objects, namely, the user, organizational role, service and directory service alias.

Figure 4. Company directory structure in the computer system

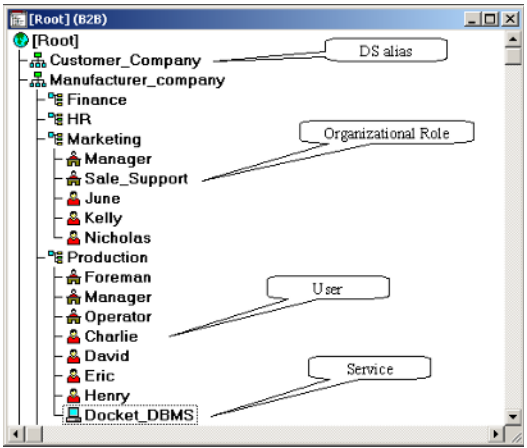


Table 1. Attributes of a user object

Key administrational attributes	Key organizational attributes
Common name (user ID)	Workforce ID
Login disabled (Boolean)	Manager workforce ID
User's Public Key	Role
Trustees (administrators)	Organizational Unit (department)
Object hash code (for fast indexing and searching)	

Table 2. Attributes of an organizational role object

Key administrational attributes	Key organizational attributes
Role ID	Role name (position equivalent)
Role description	Description of the role
Role disabled (Boolean)	Restrict whether the role is enabled
Object hash code	For fast indexing and searching

Table 3. Attributes of a service object

Key administrational attributes	Key organizational attributes
Service ID	Service name (e.g., production daily docket system, customer order tracking system)
Service description	The description of the service
Service disabled (Boolean)	Restrict whether the service is enabled
Service public key	Public key for the service
Access rules (in Well-Formed-Formula (WFF) format)	Indicate which organizational role is eligible for data-access

Table 4. Attributes of a directory service alias object

Key administrational attributes	Key organizational attributes
DS alias Name	Company name
DS server's IP address	Businesses category
DSML V2.0 support (Boolean)	Indicate whether it supports version 2

Table 5. Basic APIs for directory service operations

Function	Explanation
Boolean authRequest(ID);	False: object does not exist, authentication fail True: object exists, authentication succeed
String retrievePublicKey(ID);	ID could be serviceID or a userID, return null means that object does have a public key stored in directory service
Role retrieveRole(userID);	Query directory service to get user object's role property.
Boolean ModifyRequest (modification);	All these functions are meant for administration purpose, and they have been explained in detail in OASIS (2002).
Object searchRequest(search criteria);	
Boolean addRequest(newobject, context);	
Boolean delRequest(objectID, context);	
Boolean modifyDNRequest(old DN, new DN);	

API. Basic APIs for directory services are summarized in Table 5. For a full DSML implementation, refer to http://xml.coverpages.org/DSMLv2-xsd.txt.

The user object represents a computer user, which stores user information, both administrational and organizational. A user's key attributes are listed in Table 1. The organizational role object represents a collection of job functions, such as a production manager or sales support personnel. Its attributes are shown in Table 2. The service object represents a particular business application, which can be considered as a software service, such as a database management system (DBMS). Its attributes are listed in Table 3. The directory service alias object holds information about other directory services, which may be a directory service of a business partner or of another department. The directory service alias holds the network information about the remote directory services, as well. Its attributes are shown in Table 4.

IAA Layer

The directory service-enabled IAA infrastructure is essentially an improved network application reference model that employs a new layer called IAA as the core functional component, standing on top of the transport layer and below the business application layer, as illustrated in Figure 2. Such a dedicated layer structure facilitates the standardization of B2B applications running in the IAA infrastructure. Since the IAA layer is separated from business applications and functions below the application layer,

Figure 5. System diagram of the IAA layer

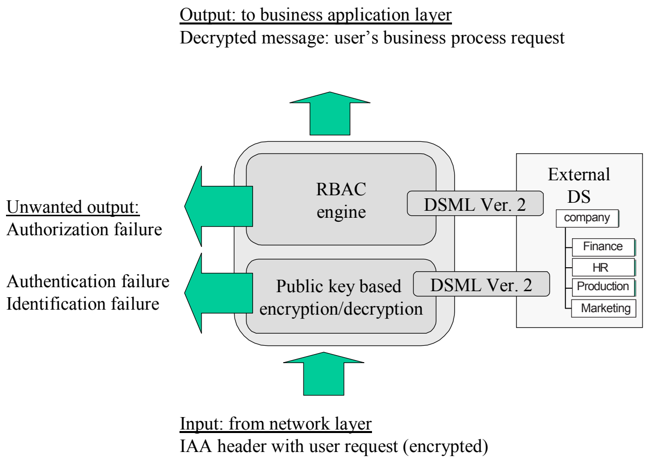


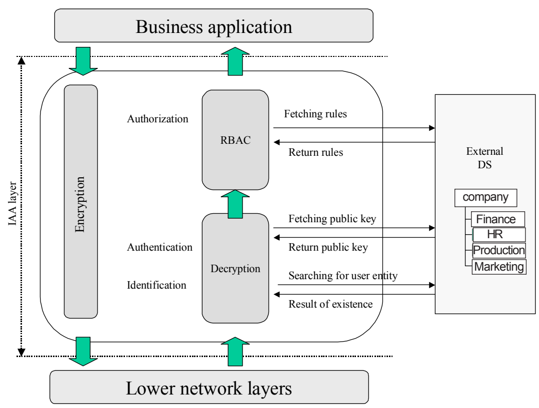
Table 6. The content of an input data gram

IAA header: encryption method	Sender's FQDN	Destination's FQDN (encrypted)	User data (encrypted)

Table 7. The content of an output data gram

Sender's FQDN	User data

Figure 6. The data flow of an IAA layer



Data flow. Figure 6 illustrates the data flow throughout the IAA layer. In the IAA layer, upstream and downstream data go through different channels, per se.

interoperability is dramatically enhanced. Therefore, system developers gain much flexibility in developing business application logics without paying much attention to IAA matters.

System description. The IAA model is a synthesized software component by integrating directory service access, RBAC, PKI and DSML, as shown in Figure 5. The input to the IAA layer is an IAA header and user data, as given in Table 6. The IAA header consists of the encryption algorithm the user data is supposed to apply, for example, 64-bit encryption or 128-bit encryption. The user data part comprises a sender's fully qualified distinguished name (FQDN) and the destination's FQDN, along with application data. The last two are encrypted by the sender's private key. The output is a decrypted message containing the sender's FQDN and user data, as given in Table 7. This information is then sent to the upper application layer for processing.

Components of the IAA layer. The IAA layer comprises three components: public key-based cryptography, RBAC and DSML v2.0. The public key cryptography is used to decrypt incoming messages from the lower layer (i.e., the network layer) or to encrypt outgoing messages from the higher layer (i.e., the application layer). The private keys of users or business entities are kept securely with themselves, either in their local PCs or a security device. All public keys are stored in the directory service, available for others to retrieve.

The RBAC component acts as an inference engine. After receiving a decrypted message, the RBAC component queries the directory service for the user's role and all rules pertaining to that role. The protocol used is DSML. First-order logics are used to infer whether a user's request should be granted. Depending on the results, the user's request may be denied or forwarded to the application layer. As an inference engine, the RBAC component calls other components' APIs.

The DSML component performs as a connector to the directory service. The LDAP can perform the same function, as well. The reason for not choosing LDAP is that the LDAP requires additional software components (i.e., LDAP clients) on both the user and the server sides. In particular, as business software is adopting XML as a standard for data exchange, the DSML, a type of XML, suggests itself as a superior solution. As a result, the same XML parser engine can be shared by the DSML component.

B2B Interactions within and Between Companies

Application Interactions within a Company

B2B applications within a company constitute two types of interactions: (1) A user sends his request to the server; and, in turn, (2) The server responds to the user's request and sends the result back to the user. Figure 7 shows the data flow from a user's computer to the server. Basically, the data is generated from the user computer's application layer, then passed to the IAA layer, encrypted and passed down to the network layer, and further forwarded to the remote server. Afterwards, the server receives the data, parses the message through its lower-network layers, decrypts the data in the IAA layer, judges accessibility and then passes it on to the server application if it is successful. The general flow chart of the server's response is illustrated in Figure 8.

Setting rules in the directory service. Managers can use a single interface to assign or remove the accessibility of the subordinates, as all the rules are centralized in the directory service under either the service object or the user object. The single-interface mode performs as a directory service configuration utility with enhanced functionality on rule configuration. The interaction between the directory service and a manager is enacted at the IAA layer using the directory service's own key pairs and the manager's key pair. Through the single interface, managers can access the directory service, and retrieve and modify the rule set of a specific object, be it a user or service.

The IAA layer uses a role-based mechanic (i.e., RBAC) to safeguard an end-user's accessibility to server applications. This enables managers and administrators to assign a user's duty effectively. The RBAC component imposes certain constraints to the assignment of duties to individual employees. Specification of such constraints forces managers away from "thinking and acting personally."

Minimizing the times of end-users' logins. With the IAA infrastructure, users need not to key in any ID and password to access other applications. Rather, this is handled by making use of the user's private keys autonomously to process any user request. A user needs to type an ID and password only once, at the first time of accessing his or her local PC. Every private key, stored either in a computer's hard disk or security device, is unlocked upon a user's login, and is locked again when the user logs out.

Application Interactions Between Two Companies

One of the difficulties of B2B applications is the management of trust relationships and data fusion (meaning who can access data and to what extent). The IAAIBB model alleviates these problems without compromising security. Any B2B application implies such a scenario that all participants have a priori agreement about certain access rights to individual data. Organizational trust is suitable to such applications (Pavlou, 2002).

Most directory service products on the market support DSML v2.0. In practice, it seldom happens that two companies' B2B systems are not compatible when they choose different directory service software. The RBAC engine of the IAA infrastructure can always query about the other company's directory service for remote user information.

A directory service alias object is added into the directory service for name resolution of remote directory services. This is very necessary, otherwise a local machine may not know where to retrieve a remote user's information. In this way, the process flow of IAA

Figure 7. System flow chart of a user sending request to the server

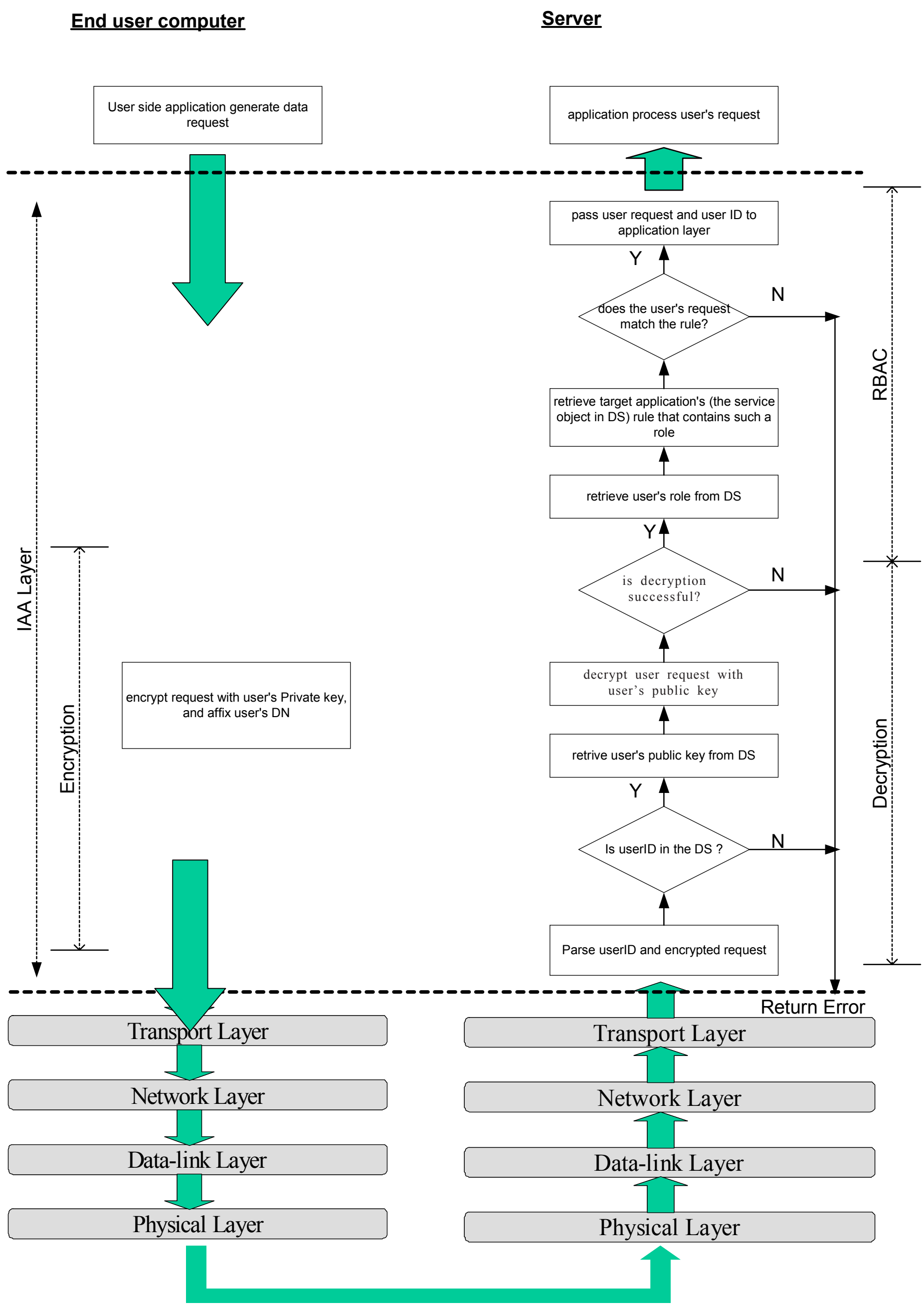


Figure 8. System flow chart of the server responding to the user

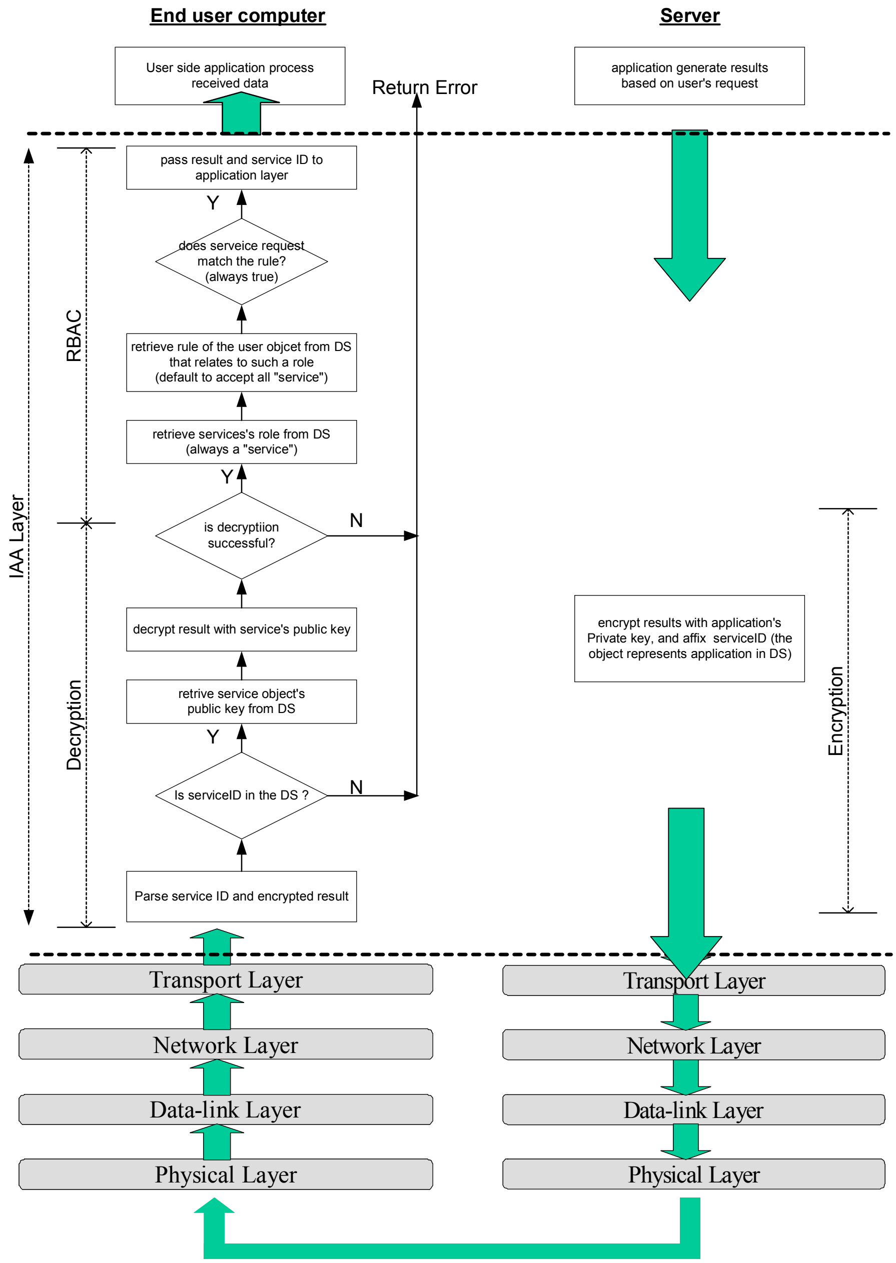
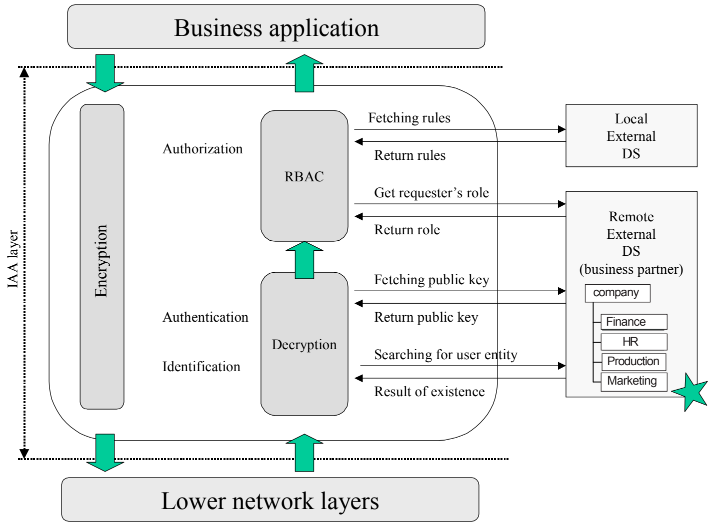


Figure 9. Interactions between the IAA layer and an external directory service



within each company remains intact. A remote user encrypts his request with his or her private key, affixes with his or her FQDN, then sends the combined message to the business partner's application server (considered as local).

In a local application server, whenever the decryption component finds a remote user, it starts to check its local directory service for the address of that remote directory service. Then it queries the corresponding remote business partner's directory service for this user's existence and possible public key. This is similar to the TCP/IP DNS service process. If any error occurs at this stage, then identification and authentication fail. Upon success of a decryption by the remote user's FQDN, the decrypted service request is passed on to the RBAC engine. The RBAC engine queries the remote directory service again for that user's organizational role predefined in his directory service. The RBAC engine further queries the local directory service (as the requested service—i.e., server application—is in the local directory service) and searches for all rules pertaining to the requested action of this particular user. If the remote user's role satisfies the rules (handled by the first-order logic algorithm), the request is handed over to the server application. If this procedure fails, it leads to service denial. Figure 9 shows the data flow using two companies' directory services for a cross-organizational transaction.

Once a request is granted and the server responds, a server application generates the result, encrypts it using its own private key, affixes it with the server's FQDN and sends it back to the remote user's machine (achieved by lower-network supporting layers).

When the remote user's PC receives the message, it processes the parsed source FQDN by querying its own local directory service for the network address of the partner's directory service associated with the server application. After getting the network address, the PC queries the partner's directory service for existence of the said FQDN and fetches the public key pertaining to that FQDN. Afterwards, decryption takes place in light of the retrieved public key. Any failure of this process leads to the failure of identification and authentication. If it succeeds, the decrypted message with the user's FQDN is passed to the RBAC engine of the user's PC. After a successful inference by RBAC, the message and the server's FQDN are further forwarded to the end-user's application layer for processing.

Implementation of IAAIBB Model

Injecting IAA Layer

There is no change to lower supporting layers. The TCP/IP protocol is still valid. The IAA layer calls APIs of TCP/IP, and also receives incoming data streams from the TCP/IP layer. As for a new business application, it needs to be designed to call APIs that the IAA layer can provide, other than calling TCP/IP APIs directly. With regard to legacy systems, three approaches are used to inject the IAA layer: (1) Rewrite the whole legacy system to talk to the IAA layer for data transmission. This is a neat approach but incurs much cost; (2) Write glue software to translate data between the IAA layer and a legacy system, meanwhile keeping the existing communication channel for a graceful migration; and (3) Inject wrappers to incorporate the communication ability inside the legacy system. But this costs the most, as existing low-level network components cannot be reused.

Setting Up a Directory Service

Selecting a directory service. According to industry analysts, such as Michael Hoch, Aberdeen Group senior analyst of Internet Infrastructure, many companies think that selecting a directory service has to be a secondary choice. But with the proposed IAAIBB model, the selection of a directory service is of the first priority. As most directory services in the market support DSML v2.0, technical compatibility is not an issue.

The Gartner Group (www.gartner.com), a market research firm, found out that large companies often maintain 100 or more directories attached to their networks, many of which possess duplicate information. The full service directory (FSD) model might be turned to for choosing a directory service. Alternatively, a company can choose a directory service according to the company's specific needs, provided that the company can understand the directory's capabilities well. For example, a human resource-oriented company may use the directory service provided by PeopleSoft, whereas a new startup company may choose Microsoft Active Directory for fast implementation and cost savings. A large company may choose to use Novell e-directory for fast response and reliable replications over different regions. A company largely depending on groupware "Lotus Notes" may choose the Lotus Notes' directory component as its core directory service. Moreover, a company may purchase a multipurpose directory service, which can facilitate the integrations of existing internal directory services.

Constructing rules. The rules under the service object in a directory service highly depend on particular B2B applications. In general, rules for the DBMS can be set using TABLE, FORM, VIEW and SQL actions, including ADD, DELETE and UPDATE operations. Rules for document-based databases like Lotus Notes may be constructed based on each individual document database with internal FORM, VIEW and ACTION operations. All in all, the more the rules are defined, the more controllability the IAAIBB model provides.

Evaluation of the IAAIBB Model

Leveraging Productivity

End-user single sign-on. For end-users, the IAAIBB model can save time, as users do not have to remember diverse user IDs and passwords. All they need to remember is a single password to unlock the access to their private key the first time they access the computer. An end-user no longer needs to type in a password for each individual B2B application. User intervention by identification is released for further data transaction. The application always picks up the user's private key to encrypt data autonomously.

With the IAAIBB model, the private key is maintained as a digital data stream stored in electronic media, and thus is always available. And the password to unlock the private key need not be changed frequently, unless both the private key and the unlock password are stolen. An end-user is totally free from memorizing and keeping track of various passwords.

Easy control configuration for managers. The IAAIBB model helps corporate systems to function as an organizational role instead of individual employee. For example, even if the purchasing manager is changed to another person, as long as the new person's role is set as a "purchasing_manager," all configurations need not to be changed and the new manager is still able to access a partner's docket data immediately.

The IAAIBB model provides a single interface for managers to configure access rules for different organizational roles. This is because all the access rules are consolidated inside a unified directory service. The single configuration interface is probably a directory service configuration utility with enriched functionality on rule construction and assignment.

A company's system can easily integrate or extend its data access into another company's systems as long as the new partner has adopted the same IAA layer and provided directory services for public access. The IAAIBB model also helps managers improve the productivity of a new employee on the first day. A manager can use the single interface to add access rules for the new employee if he or she is to hold a new organizational role. As for an existing role, everything becomes much simpler. The manager only needs to assign it to the new employee and, in turn, this new employee immediately has access to all necessary network services because they already have been set up. This also applies to the case of job relocation.

Enhancing Security

Local processing of passwords. It is safe to use a password to unlock a local private key, because the unlocking procedure is done locally. An end-user uses the password to unlock his or her private key the first time he or she accesses the computer. Because the unlocking process is done within the local computer, there is no means for a network hacker to capture the password over the network wire. The password can only be revealed within the workplace. Hence, the end-user has more confidence in securing a password.

Secured transactions. To enhance data confidentiality, the IAAIBB model encrypts data using advanced PKI cryptography techniques for every transaction. It is very difficult to crack such an encryption algorithm, because there are a large number of possible combinations of key pairs, which requires a very sophisticated algorithm for decoding. And the cost of cracking such a public key-based cryptography is much higher than the benefits of getting the encrypted information. In addition, superior executives can set strict rules in the directory service that the RBAC engine must refer to. Once a user is demoted from an eligible role, that user is no longer able to access data pertaining to his or her previous role.

Authentication in IAAIBB is more advanced than that using plain text passwords. A plain text password only needs a simple comparison with a stored password at the server side. But with the IAAIBB model, a user's private key is always kept locally, not in the server. Hence, as long as the user keeps his or her private key properly, other people have no way to fraud the system by impersonating the legal user. Hackers also have no chance to get the private key even if they have managed to access the server via lower-level security black holes. Furthermore, a person's directory service object (i.e., the user object) can be removed immediately after he resigns. Therefore, even though the user keeps his or her private key, the user's request will never pass the authentication phase at the IAA layer, as there is no item in the directory service to match with the user's FQDN. Hence, the application layer will never receive a request from the ex-employee.

The IAAIBB model also enhances data integrity. The data going through the network wire is encrypted. Because the receiving computer is not able to decrypt the data using the sender's public key, any change to the encrypted data stream will lead to decryption failure at the receiver's computer, and thereby the request will be rejected.

Cost Savings

The calculation below is based on a reasonable assumption of a SG$2,000 average salary in Singapore in year 2003 in a medium-sized company (around 500 employees). Assume that an employee has to key in a user ID and password four times a day on average. Sources of data used in cost calculation are summarized in Table 8.

Cost savings from reduction of end-users' keying in user IDs and passwords. Considering such scenarios as a password that a user has already memorized or one that is rarely used but the user has written it down somewhere, the input of a user ID and a password takes 40 seconds on average. The non-value added cost for all users to key in passwords per year is thus given as:

(Number of employees)(Annual Salary)*(hours used in keying in password)/(working hours a year) = 500*(SG$2,000/month*13 months)*(4*40/3600*250 days)/(250 days*8 Hours/day) = SG$72,222.*

If using the IAAIBB model, the cost figure is given as:

500(SG$2,000/month*13 months)*(10/3600*250 days)/(250 days*8 Hours/day) = SG$4,514.*

The rate of cost savings is:

(72,222-4514)/72,222=92.5%.

In the above cost analysis, the indirect cost has not been counted. The indirect cost may include password recovery cost, password re-issuing cost, as well as manpower and materials related to recording and tracking passwords.

Table 8. Data source for cost calculation

Data item	Description	Resource
1	IT admin staff's salary	"Singapore salary guide 2003" *www.businesstrends.com.sg*
2	Resignation rate and recruitment rate	"Statistics on Productivity" Standards, Productivity and Innovation Board of Singapore *www.spring.gov.sg/portal/stats/productivity/productivity.html*
3	Data-entry time for handling resignation	"I-Login – one Net for Novell Employees" Linda Kennard. 2002. *Novell Connection*, Feb, 10-12 *www.novell.com/connectionmagazine/2002/02/ilogin22.pdf*

Cost savings from service provisioning and de-provisioning. Service provisioning means the process for providing a new employee with access to all necessary network resources. Accuracy and time are the measure for the effectiveness of service provisioning. In a dispersed network application environment, line managers have to talk to IT staff to grant access to the new employee's ID in each system. If using the IAAIBB model, once the new user ID is activated associated with an existing organizational role, the new user immediately possesses all access to the systems available to that particular role.

Service de-provisioning means that when a person leaves a company, all network services and data services assigned to that user should be terminated immediately. But it is hard to achieve this in today's dispersed network application environments. It takes much time, because managers and IT staff have to scan through all the systems. If that person is a network administrator, the IT department may have a headache to change all passwords, because the ex-administrator probably knows all users' passwords. With the IAAIBB model, this security threat is eliminated. Once a user leaves the company, that user's name will be deleted from the directory service immediately. Even if the ex-employee tries to access a system application using the private key that he or she still keeps, the IAA layer will never let the ex-employee's request pass through.

The cost savings using the IAAIBB model can also be projected. The total cost before adopting the IAAIBB model is given as:

(number of workforce)((resignation rate)+(recruitment rate)+(intra firm relocation rate))*(hours for data entry for every case)*(hour pay for IT admin staff) = 500*(2.2% + 2.6% + 0%) *1.13 hrs*(SG$4,000*13/(250*8)) = SG$705.*

With the IAAIBB model, the deletion of a user object in the directory service costs the maximum of 1 minute. The cost is to be:

500(2.2% + 2.6% + 0%)*(1 minute/60 minutes/hour)*(SG$4,000*13/(250*8)) = SG$10.4.*

Therefore, the rate of cost-saving is:

(705-10.4)/705=98.5%.

Extended Network Access

An open infrastructure. As long as the participating business partners have adopted the IAA layer in their networks and set up their own directory services, they can be allowed to access another company's network services (i.e., server applications) with only a few policy settings. No extra client software is needed. External users can use the existing internal client software without any modification. Whether the other party can access data is controlled by the local directory service. This saves time and effort for developing extra client software for external users, and thus helps to standardize business processes. In this sense, the IAAIBB model breaks down the barriers between the Intranet, Extranet and Internet in a B2B commerce environment.

Integrating heterogeneous systems. Different companies use different internal application systems. And even their internal connection topologies are different. To integrate them, a common acceptable infrastructure performing as a standard to speak both technological and managerial languages would be a best solution. The IAAIBB model fits into this niche. It is based on a hierarchical directory structure that executives are familiar with. It uses sound technologies like RBAC and PKI cryptography that professionals in the computer networks and system development areas understand well. The difficulties in coordinating system developers and corporate executives are thus alleviated. This facilitates the achievement of successful system integration.

Summary

This chapter introduces the idea of integrating the directory service to business applications. An infrastructure model, called IAAIBB, is proposed. The significant contribution of the IAAIBB model is the achievement of *single sign-on* for end-users. It also provides an open infrastructure for business applications in terms of identification, authentication and authorization. With the support of the IAAIBB model, each end-user no longer needs to remember and keep track of a user ID and password for every application, but simply provides a single password to unlock his or her private key the first time the user accesses the computer. After that, all applications will make use of the unlocked private key autonomously. Moreover, the IAAIBB model separates the IAA security module from the application layer by taking advantage of advanced computer technologies. It makes it easier to leverage on system interoperability, while keeping existing business logics valid and intact. This merit lends the IAAIBB model to the potential of being extended as an open-infrastructure standard for B2B applications.

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Chapter XI

Autonomous Environmental Scanning on the World Wide Web

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Abstract

Environmental scanning (ES) improves managerial decisions by linking the business environment with the organization's internal capabilities. This chapter provides an overview of current developments in ES, underscoring the link between the managerial decision-making process and the different modes of scanning both internal and external information sources, particularly the World Wide Web (WWW). The psychological foundations of human ES activities are scrutinized, and cutting-edge technologies that support monitoring or even scanning of autonomous information sources are discussed to integrate both aspects in a holistic perspective on ES. We identify the most serious challenge in ES to be the detection of relevant sources in vast information environments. Based on the Information Foraging Theory (IFT), we propose an innovative approach to assessing the information gain offered by digitally available sources.

Introduction

ES refers to the way in which managers study their relevant marketing environment. Scanning is a more challenging task than monitoring information sources, because a broad range of internal and external sources have to be exploited, data in different (often ill-specified) formats have to be combined, and the topics, as well as the information sources of interest, cannot be exhaustively described a priori but rather, emerge during the scanning activities. Aggravating this, managers typically have to limit their attention to very few data sources and, thus, exclude all other potentially relevant information sources. Consequently, there is constant competition for the manager's limited attention between different topics, information sources and fragments. Herbert A. Simon highlighted this interrelationship in the following way (quoted by Varian, 1995, p. 200): "What information consumes is rather obvious: It consumes the attention of its recipients. Hence, a wealth of information creates a poverty of attention and a need to allocate efficiently among the overabundance of information sources that might consume it."

The importance of ES activities to managerial planning processes is widely accepted and supported by empirical results. Several studies show a strong connection between ES efforts and business success (Analoui & Karami, 2000; Daft, Sormunen, & Parks, 1988; Dollinger, 1984; Miller & Friesen, 1977; Newgren, Rasher, & Laroe, 1984; Ngamkroeckjoti & Johri, 2003; Subramanian, Fernandes, & Harper, 1993; West, 1988). ES helps managers foresee favorable as well as unfavorable influences and initiate strategies that enable their organizations to adapt to their environments. Slaughter (1999) has noted that ES is an up-and-coming industry. ES should improve short- and long-term planning (Sutton, 1988), and should lead to a better understanding of external changes. At its best, ES is the first step in a well-organized chain of activities that lead to environmental adaptation (Walters, Jiang, & Klein, 2003); however, the actual managerial reality is found to be less structured and orderly (CIO Insight, 2003; Muralidharan, 1999). Meanwhile, the massive body of scholarly work (see Choo, Detlor, & Turnbull, 2001; Dishman, Fleisher, & Knip, 2003) for a detailed bibliography of scholarly contributions in the fields of competitive intelligence and ES, respectively) has not found a suitable impact on managerial practice (Wright, Pickton, & Callon, 2002), for various reasons. First and foremost, this might be attributed to the perception of managers that systematic ES is user unfriendly (because of its quantitative methods) and too complex (and thus simultaneously oversimplified, because of reducing scope to very few of the relevant variables) and, therefore, might make them lose ground (Day, 2002; Wind, 1997). Instead of systematically seeking for information on developments and changes, managers tend to reduce their cognitive load by restricting information gathering to exceptional events, such as preparation meetings devoted to strategic planning. In this case, the information-gathering task is commonly delegated to assistants or specialized market researchers and consultants (Chouldhury & Sampler, 1997; Lim & Klobas, 2000).

Previous research establishes that managements' cognitive inertia in responding to environmental changes increases the probability of mistakes in marketing planning (Daniels, Johnson, & De Chernatony, 2002; Reger & Palmer, 1996). But, even when this psychological obstacle is overcome, the manager faces serious difficulties in utilizing information from ES activities. Wright et al. (2002) report from an empirical investigation that the lack of time to engage in systematic ES make the information and structure relevant, and ensuring that relevant information is opportunely available are commonly mentioned problems in United Kingdom (UK)-based organizations. Dishmann and Pearson (2003) argue that the ineffectiveness of many ES activities arising from these problems led to a downsizing of ES efforts in many United States (U.S.) firms. This problem becomes even more serious in the context of ES activities on the WWW, which provides—on the one hand—a massive information base covering new up-to-date information, but—on the other hand—does not provide this information in a well-structured and easily accessible manner. Professional tools for managing the ES process and systematizing these information sources are still not widespread in practice. Standard search engines, such as Google or Altavista, seem to be a great help in retrieving meaningful, relevant information at first glance, but do not organize search results in a serviceable manner (Tan, 2002). Thus, the manager may, at times, obtain excessive information and—as a consequence thereof—get drawn into a search process that could extend unreasonably. Considering these gaps between the claims of ES-related literature and managerial practice, this chapter aims to:

- Derive a system of scanning modes that fits practitioners' needs as well as covers the recent progress in ES by new Web technologies.
- Outline the linkage between ES in different modes and the stages of the managerial planning process.
- Provide an overview of current ES software tools' features.
- Outline a new approach for autonomous ES on the WWW.

To meet these goals, we outline how to keep up to date with ES activities from the practitioners' perspective, which is affected by limited resources and the need for timely information. We also explain how to choose the right scanning mode in different stages of the decision-making process. Researchers might benefit from the comparison of different frameworks in order to link their research approaches and results to the contemporary patchwork of scholarly knowledge. Moreover, both groups may take advantage of the description of currently available monitoring software and recent technological advances to support autonomous scanning activities on the WWW.

The remainder of this chapter is organized as follows. In the next section, we explain the concept of ES and delineate the relation to similar challenges, such as competitive intelligence and weak signal detection. Subsequently, a framework for ES is derived to explain the underlying structures and shortcomings resulting from the systems involved in ES and their interactions. Therefore, an alignment of the ES process to managerial decision-making is provided. Moreover, we discuss the state of practice in supporting software tools for ES in the context of this framework. In doing so, we return to a cognitive-driven approach derived from psychological insights in the field of information-seeking behavior, namely, the IFT (Decker, Wagner, & Scholz, 2005). The functionality of this autonomous ES approach is briefly outlined by means of a prototypical system in a proof-of-concept-test. Finally, managerial implications are drawn for both the use and development of autonomous systems supporting ES.

Ingredients and Targets of Environmental Scanning

Scopes of Environmental Scanning

A major issue in ES is balancing all of the drawbacks associated with grasping a very broad range of heterogeneous sources (which may lead to serious confusion due to irrelevant facts) with the disadvantages that emerge from ignoring or missing relevant facts by being restricted to very few or a set of homogeneous sources. Referring to Jauch and Glueck (1988), the external environment consists of the following six areas: (1) customers, (2) suppliers, (3) competition, (4) socioeconomic, (5) technological, and (6) governmental. A rather similar segmentation was introduced by Olsen, Murthy and Teare (1994), as well as by Goshal (1985), who differentiates the environment by competition, market, technology, resources, regulatory and global issues. Noticeably, all of these enumerations are restricted to external sources and, therefore, are useful for external ES only. In line with Frishammar (2002), we refer to external ES as follows:

Definition 1 (External ES): External ES is defined as both looking for and looking at information available in the six relevant areas: customers, suppliers, competition, socioeconomic, technological and governmental. These activities embrace all domains of gathering facts from external sources like competitive intelligence and market research, but take a more holistic, integrative perspective by considering consumers, competitors and technological developments in the same industry and different industries, as well.

Walters et al. (2003) provide an importance rating of various environmental sectors in the U.S. manufacturing industry matching our aforementioned definition, which is flexible with respect to the sources covered. Clearly, the focus of attention should be directed to sources related to areas considered as important in the individual business environment (Garg, Walters, & Priem, 2003). The WWW is found to be a commonly used information environment in this context. Choo, Detlor and Weibull (2000) identified the WWW as the second-most frequently used information source by CEOs in ES, dominated only by the use of mass-media information sources. In that study, consulting colleagues in the same department is the third-ranked source of information. Paradoxically, scanning internal information sources is less discussed in management literature and frequently skipped in business practice, although CEOs who match internal and external ES activities are found to perform significantly better (Walters & Priem, 1999). According to Davenport and Prusak (1998), internal knowledge can be seen as the most important source of information, as it is the only source that cannot be easily replicated by competitors and is, thus, a key factor of competitive advantage. The internal environment might be structured using Porter's (1998) value chain concept, organizational charts or the structure underlying organizations' management software systems and enterprise resource planning systems (e.g., PeopleSoft, Oracle, SAP).

In addition to the different sources to be considered, internal ES differentiates from external ES with respect to the "relevant areas," as well. Two questions raised by Hambrick (1981) and Serpa (2000), namely "which sources" should be scanned and "which behavioral dimensions" make up the scanning process, are useful to structure the scanning issues for practitioners. The latter is targeting organizations' culture, motivation and mood of employees as well as shifts in task-related interests; but also, hard facts, such as productivity, sales and some figures from controlling, might be of interest. Answering the first question is even more nebulous because of organizations' heterogeneity. To give a few examples, mission and values statements, assessments of previous strategic plans, interviews with leaders of various departments, hiring policies, meeting protocols, and—of course—performance indicators as well as balanced score card evaluations can be used to find the answer to this question. Integrating the descriptions of Goodstein, Pfeiffer and Nolan (1991) and Garg et al. (2003), we define internal ES:

Definition 2 (Internal ES): Internal ES is defined as both looking for and looking at information available within an organization. Gathering information is not restricted to available indicators, but also covers informal and implicit knowledge. The activities are targeted towards already processed information concerning the organizational environment, as well as organizational resources linked with changes in the organizational environment.

The internal scanning process has a closer link to management activities, particularly to marketing planning, due to its target of organizational resources. Before an organization can cope with the task of concrete strategy formulation, it needs to gain a sound understanding not only of the external environment but also of its internal environment to match possible opportunities and threads identified in the external environment (Hough & White, 2004). Antecedents and consequences of different manners of matching organizations' resource allocation to the contemporary external environment for creating competitive advantages have been discussed in detail by studies of the "resource-based view" of organizations (c.f. Hunt & Derozier (2004) for a recent compilation of related literature). A well-established result of these studies is the failure of business plans relying solely on external ES because implementation encounters resistance from inside the organizations. But, the question "how to gather" the relevant information appears to be a blind spot in literature, particularly in quantitative and model-related planning literature. Investigating the managerial practice, Walters and Priem (1999) found the preference for internal or external sources to be strongly linked to business strategy: CEOs of organizations committed to differentiation from competitors consider the external environment as more important than CEOs of firms pursuing a cost-leadership strategy. Xu and Kaye (1995) suggest that the balance between internal and external scanning should be 20:80. A recent study by Garg et al. (2003) provides new insights in the cohesion of environmental dynamism and successful allocation of internal and external scanning efforts in smaller manufacturing firms. Good advice to managers operating in stable environments is to emphasize internal and external environmental sectors associated with *efficiency*. In contrast, managers facing highly dynamic environments should emphasize their scanning tasks on internal and external sectors associated with *innovation.* The latter objective has received substantial attention in management literature because it makes up the interface of ES and weak signal detection (Decker et al., 2005). This interface is discussed next.

Environmental Scanning and Weak Signal Detection

The concept of weak signals as introduced by Ansoff (1975) has received substantial attention in strategic management literature. Ansoff called for a nexus between ES and weak signal detection by suggesting both scanning externally and internally for warnings.

Definition 3 (Weak Signal): Weak signals are emerging patterns of knowledge that are not explicit but rather subtle, implicit and dispersed in many sources. The separated information fragments are proximal cues for the likelihood of the same future events. Neither the direction nor the magnitude of impacts are deterministic, but might be sensitive to organizations' adaptations to changes in the business system.

When being communicated by at least one credible sender—for example, an expert of the relevant domain—the signal becomes strong. Since the strong signals are commonly received and adapted by all competitors in a market, only the identification of weak signals, before they become strong signals, offers the potential to create competitive advantages.

The environment is constantly emitting a countless number of signals revealing slight future trends and developments, and no individual or organization can pay attention to more than a small fraction of them. In the early stages, the signals are small, indistinctive marks that can hardly be separated from the background noise. But, the earlier the organization detects these weak signals, the more time it has to successfully align strategic decisions to emerging, forthcoming changes in the business environment. The central task of ES is to provide sound methodologies for the successful detection of relevant changes heralded in the information environment. Martino (2003) outlines the development of signals from poor to strong in the field of technological forecasting. Modern computer technologies can help identify the maturity of signals by means of data mining and bibliometric analysis of textual information sources. In particular, the WWW supports the timely, unfiltered provision of signals in the early stages; that is, while still fuzzy and weak in nature. These signals can be found in various white papers online of research institutes and newsgroups that discuss up-and-coming phenomena and possible future scenarios without caring too much about information quality or origin. Since information is often available on the WWW without even moderate censorship (such as typically exists in commercial/business journals and newspapers), signals heralding new developments at an early stage are more widespread than in traditional published information sources. Commercial newsvendors have to consider the impact of false information and, therefore, must be more cautious when offering information. This quality check takes time and often leads to substantial time lags in the publication process. The most relevant characteristics of the information fragments available in the Internet are their vagueness and the absence of links to other information that would make a consistent and meaningful picture. Thus, linking information fragments from different sources is the main challenge for the identification of weak signals, according to Definition 3. While wide areas of the environment have to be scanned to detect crucial changes, the managers' information needs are often focused on a specific task, so they restrict themselves to few information sources thought to be the most relevant with respect to the task at hand. For instance, Nitse, Parker, and Dishman (2003) use multi-class interest profiles to dissect information needs according to the task environment of the managers. These profiles allow a segmentation of the information space in well-defined areas to facilitate a detailed search.

The concept of weak signal detection is frequently criticized as of limited use for practitioners because of the lack of generally accepted instructions on how to obtain the signals. However, Nikander's (2002) detailed investigation based on semi-structured interviews comes to the conclusion that weak signals exist, but the a priori identification is still challenging. Myers (1999) notes that text rich in weak signals exhibits variety and includes sources beyond those familiar to players in the immediate field of competition, and some sources may be considered illegitimate. Given different fragmented information spreading over various sources in diverse formats, both filtering of sources and combining of sources to firm up weak signals is needed. The practice of delegating these tasks to creativity or scenario workshops (e.g., Petersen, 1999) seems to be unsatisfactory for three reasons:

1. Since the participants should be experts in at least one domain, their statements are likely to be perceived as strong rather than as weak signals.
2. Due to the limitations of human information processing capabilities, the participants will previously filter with respect to their focus of interests before trying to combine information fragments in a second step (Ilomla, Aaltonen, & Autio, 2002).
3. Cutting-edge developments will be excluded because of this heuristic proceeding if the experts crowd out presumptive irrelevant information fragments in their specific domains before combining a consistent up-and-coming pattern with information fragments from other domains.

Thus, systematic ES activities might be the first step to answering practitioners' questions left open by scholarly work dealing with weak signal detection.

Integrating the Perspectives

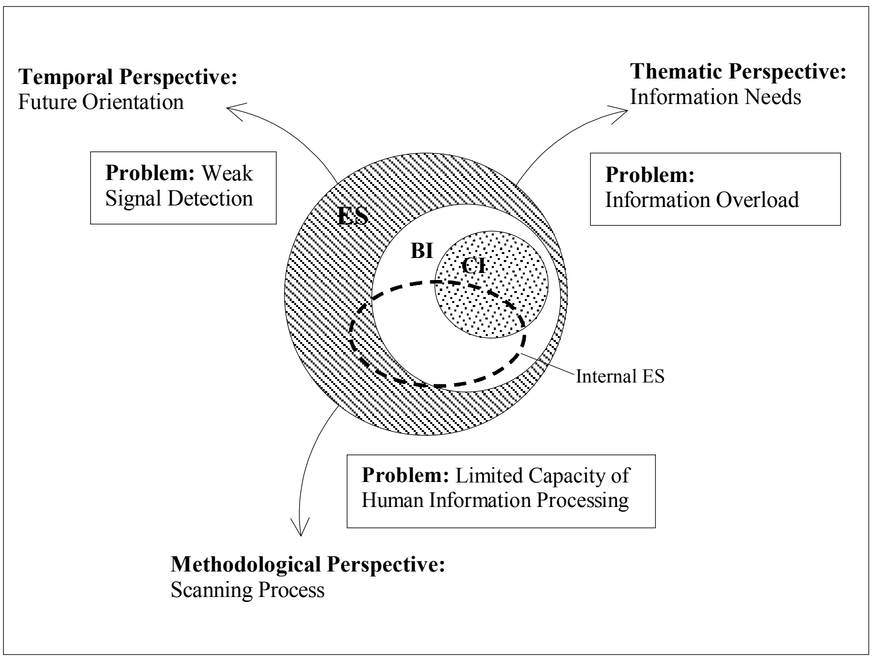
Almost all scientific research in the area of ES is descriptive and utilities case studies (Aguilar, 1967; Correia & Wilson, 1997; Ebrahimi, 2000; Miller & Friesen, 1977; West, 1988). Despite the amount of empirical research that has been done, Choo et al. (2001) as well as Hough and White (2004) point out that the theoretical understanding of organizational ES is still limited. Xu and Kaye (1995) remark that despite all research efforts in the field of ES, insights in the question of *how* information is actually processed into managerial decisions still remains hidden in a black box. The lack of generally accepted theories that combine the different aspects of temporal (e.g., how to gain future orientation instead of a retrograde perspective), methodological (e.g., which scanning modes should be followed) and thematic (e.g., which areas of the information environment are most important) issues in ES leads to the problem that the results of these studies are mostly restricted to interpretations in the context of a specific organization or industry. Due to this, an exhaustive generalization of these results still appears to be a blind spot in the literature (Hough & White, 2004).

Several reasons might account for these deficits, but two obstructions are rather obvious. First, the studies are constricted by their subject—for example, Business Intelligence (BI) or Competitive Intelligence (CI). Second, most of the studies are constricted by their perspectives, which cover either the combinations of signals from various sources, the information overload or human information processing. Figure 1 visualizes the relations between the aforementioned subjects and perspectives.

As we can see in Figure 1, internally available information is mostly accessible in BI, due to electronic records of consumer transactions that become standard with modern ERP and CRM software tools. In CI, the use of internal information is also an established business practice; for example, in terms of sales force reports and debriefing of new employees that have worked previously with competitors (Xu & Kaye, 1995).

Only a fraction of the relevant aspects of the external environment are typically existent

Figure 1. Subjects and perspectives in IS



in the internal environment. This information consists of prior aggregated information about the environment, such as historical data (e.g., marketing research reports) or previously developed future scenarios about developments to be reconsidered in the light of new emerging phenomena. According to Davenport and Prusak (1998), intranet technologies provide promising solutions for managing knowledge repositories and allow quick access to the sparse and distributed internal knowledge about the external environment.

Analogically, the Internet—in particular, the WWW—provides the manager with excellent external information. Trends in business, science, society and politics are digitally announced on the WWW long before their consequences are observed in the real world (Decker et al., 2005). McGoangle and Vella (1998) argue that 90% of all information needed by a company to make critical decisions is already public or can be systematically developed from public data. Due to the fact that the WWW is both a publishing medium and an indispensable element of daily communication, almost all up-and-coming real-world phenomena are discussed in the virtual reality of the WWW. Therefore, Choo et al. (2001) refer to the Internet as a "social information space." Tan, Teo, Tan, and Wei (2000) argue that the WWW changes the traditional approach to ES in the following ways: It allows smaller organizations to overcome resource barriers. It changes the role of external consultants by shifting the focus from information acquisition to consultancy, and also provides organizations with quick, up-to-date information about competitors that was previously unavailable. However, due to the massive information supply—Google already indexes more than eight billion Web pages—efficiently searching this information space requires a considerable understanding of ways to manage the selection of information fragments, primarily because the WWW opens up a mind-blowing volume of ill-structured information. Search engines provide fundamental support in detecting relevant information, but are far from being sufficient tools for ES. The dynamic and largely unregulated nature of the WWW is making it increasingly difficult to locate relevant information at reasonable costs (Chen, Chau, & Zeng, 2002). Ding and Marchionini (1996) found the precision ratios of search engines to be rather poor. Testing three search services, they discover that less than 55% of the first 20 retrieved Web pages match the query. Moreover, Lawrence and Giles (1999) have estimated that search engines index only 16% of all information sources available on the Internet. This means that new information capturing weak signals is not linked with already established and indexed Web sites, so it is likely to be ignored. Building upon Stigler's (1961) search theory, information foragers have to balance information quality with information price (e.g., search time) (Harrington, 2001). Noticeably, search engines do not provide any reference to the credibility of the information originators, such as humans are used to in assessing printed media. The only hints given by search engines are a few key words describing an information source and an assessment of congruity with the query (Nielsen, 2000). However, from a practitioner's perspective, an integrated framework guiding and systematizing the ES process would be very beneficial in increasing efficiency as well as clarifying the information needs and, thus, triggering the ES process in a dynamic, volatile and unstructured environment such as the WWW.

An Integrative Framework for ES and Decision-Making

The scanning process is influenced by three constitutive subsystems: stages of the human decision-making process, modes of searching in this information environment and the design of the computer system support used to aid the scanning process. These subsystems and their interactions have a substantial impact on the overall quality of results (Slaughter, 1999). Next, we outline the subsystems and their main constraints influencing the ES process in detail.

Human Decision-Making

From the strategic perspective of a managerial decision-maker, the deliberative and rational decision-making progress is a sequence of five stages: (1) give attention to a problem or opportunity, (2) collect information, (3) develop a set of alternatives, (4) evaluate the alternatives by expected costs and benefits and, finally (5) choose the alternative offering the maximal utility (Frederickson, 1984; Mitchell & Beach, 1990). From the information-processing perspective, the unpredictable and dynamic environment forces managers to search for additional environmental information (Hough & White, 2004). Actually, the supportive activity of ES is mainly done in the first four stages of the decision-making process.

First Stage: Give Attention to a Problem or Opportunity

Empirical studies support the thesis that too much information negatively affects the quality of decisions as much as insufficient information does (Buchanan & Kock, 2001). Cognitive psychological research provides detailed information as to how human beings perceive stimuli (Anderson, 2000). It has been shown that human beings possess a screening mechanism for stimuli (Neisser, 1987); that is, when a stimuli reaches the brain it takes less than 5 seconds to decide whether or not it is interesting for the receiver. This implies a reduction of the real world's complexity through mental models for human information processing (Johnson-Laird, 1983). The accuracy of these mental models can vary as a result of personal traits and the state of expertise of the manager as well as the characteristics of the business environment that has to be modeled (Day & Nedungadi, 1994; Reger & Palmer, 1996). There is empirical evidence that managers' mental models also influence their decisions and firms' outcomes (Huff, 1990).

The constraints in human information processing strongly affect the decision-making process presented above. The manager can only scan and process a small fraction of the business environment at a time (Analoui & Karami, 2002). The manager's focus of attention and awareness of certain phenomena determine the problems and opportunities noticed in the business environment. According to Hamrefors (1998), the design of scanning activities has a major impact on the perception of environmental information.

Only if the person is in constant interaction with other persons or at least intelligent systems will that person be able to enrich the given information with new and varying perspectives to gain a satisfying picture of the real-world situation.

Second Stage: Collect Information

The mental model of the manager is a key driver of his or her actions in the second stage of the decision process, where information is gathered to expand the already existing knowledge. Mental models can help recognize and understand new phenomena apparent in the business environment, but can also lead to serious inertia, misinterpretations or even ignorance, because managers tend to maintain accustomed ways of thinking and interpretation (Nystrom & Starbuck, 1984; Rouse, 2002). Slaughter (1999) argues that the empirical scanning frame is inclined to overlook phenomena that do not respond to already established "ways of knowing." That is, the manager's cognitive representation leads his attention to well-known concepts and induces a prejudiced perception of the real world. Thus, it is important not only to avoid lapsing into familiar patterns, but also to be open-minded to new interpretations and environmental constellations that necessitate new concepts.

Third Stage: Develop a Set of Alternatives

Similar cognitive structures become operative in the third stage when sets of alternatives are evaluated. One of the key elements to solving a problem is to find a good way to represent the problem (Simon, 1973). Newell and Simon (1972) proposed that problem solving consists of a search in a given problem space. This space has an initial state, a goal state and a set of operators that can be applied to move the solver from one state to another. Bigger problems are usually characterized by a richer gamut of options at any point of the problem space. In contrast to formal decision theory, the problem solvers are not presumed to have the entire problem space represented in their mind when they are trying to solve the problem. In many situations, they will not be able to consider all possible problem states and will have to search the problem space to find the solution. Thus, one of the most important aspects of problem solving is searching for a path through the problem space that will lead to the goal state. Human problem solvers frequently use heuristics that allow them to move through a problem space (Krabuanrat & Phelps, 1998).

A different approach to problem solving claims that the crucial process is insight instead of search (Davidson, 1995). Thus, managers should scan for new, additional information from internal and external sources, but also take time to find new perspectives to the accessible organization's knowledge. This could imply the extensive use of executive information systems (EIS), which are especially helpful when applying exploration metaphors for discovery in warehouses, such as data cubes (Riedewald, Agrawal, El Abbadi, & Pajarola, 2000). Usually, internal sources are scanned first to identify a solution for the problem at hand. If this does not satisfy the information needs, external sources are taken into account.

Fourth Stage: Evaluate the Alternatives by Expected Costs and Benefits

The fourth stage is also affected by the characteristics of human mind. Humans have difficulties in the assessment of new information structures, but are rather good at recognizing already-assessed information structures (Rouse, 2002). This backward orientation means that mostly old and well-experienced cognitive models are used instead of building up new insights in the developments of the environment (Nystrom & Starbuck, 1984). Nastanski (2004) supports this thesis with his findings in a recent explorative study. The meaningful interpretation of changes and the communication of these insights to others are regarded as key issues in surveyed high-technology organizations. That is to say, information should be presented in familiar ways so other managers can grasp and evaluate the issues quickly and easily. Up to now, managers are trained in exploiting documents focusing on delimited and explicit phenomena rather than combinations of information fragments gathered from the WWW.

Fifth Stage: Choose the Alternative Offering the Maximal Utility

In the fifth phase, there is a shift in management intention. While in former stages information was processed to firm up the picture of the world, in this stage, information is used to argue the chosen decision. Referring to the "classical" marketing planning process, as illustrated, for instance, by McDonald (2000), this stage refers to the strategy formulation process. Often, well-known and established modes of representation, such as those contributed by marketing theory (e.g., Porter or BCG matrixes) are used in this phase. ES is used for confirmation or monitoring of already anticipated theoretical concepts—making up the managers' mental models—as well as related observed phenomena.

In sum, the five stages of the managerial decision process are characterized by different qualities of previous knowledge and—as a consequence thereof—different information needs, which call for diverse strategies in obtaining new information. To avoid inefficiencies or—even worse—fall into the trap of ignorance, the information-seeking strategies should match the concerns of the decision maker's mental model.

Modes of Searching in this Information Environment

Organizations have to cope with substantial interdependencies in their external environment. These interdependencies lead to three challenges organizations have to meet (Frishammar, 2002; Liu, 2001):

- Interdependencies call for a broad view of the external environment, since many factors can influence the existing and future business.
- Internal factors, particularly resource related, need to be evaluated.

- Due to the complexity and irreversibility of modern business strategies, an alignment to changes of these factors takes time.

In ES literature, different ways of gathering information are frequently described (Ebrahimi, 2000; Hough & White, 2004; Wilson, 1997). In his seminal work, Aguilar (1967) distinguishes four types of scanning behavior: (a) undirected viewing (which is executed without a particular purpose); (b) conditioned viewing (the individual is able to assess the value of the exposed information); (c) undirected search (as an unstructured search process); and (d) formal search (where the manager is actively searching for information or solutions to a specific problem).

Wilson (1997) proposes a different categorization. He labels the acquisition of information without purpose as passive attention (a), and passive search (b) as when new information is obtained during the search for information of a different kind. Active search (c) refers to the process of actively looking for certain information. Ongoing search (d) describes the process of searching for information when a basic comprehension of the search area already exists and the search should extend the available understanding of ideas, opinions, values and so forth.

While these classifications give a detailed description of how managers can obtain access to new information, we will present a separation of information-gathering behavior that refers to the state of the manager's mental model. The manager's mental model directly determines his information needs and, ultimately, affects his or her scanning behavior.

If the manager strives to extend the existing mental model, he will scan the environment to find new phenomena and concepts as yet unknown to him. A manager even may be exposed unexpectedly to information that might be of interest but is not already cognitively represented, thus perhaps discovering a new phenomenon or concept. This detection happens in an active, but random, manner, since no sophisticated concepts are available to guide or search for these new phenomena. Of course, the probability of detection is interlinked with the manager's disposition and exposition to the environment. Correspondingly, this mode of scanning behavior will be characterized as *discovery*. In the discovery mode, the identification of weak signals according to Definition 3 is one of the dominant challenges.

If the manager already possesses a fairly rough cognitive representation of an interesting phenomenon, it is useful to refine and amend the concepts with further information. New information sources are actively searched or passively exposed to improve basic understanding and interpretations. In doing so, the manager increases expertise in this particular area of the information environment. This mode of information seeking will be called *expansion*. If any weak signals have been discovered successfully in the previous stage, the managers have to engage external ES activities according to Definition 1 in this stage.

A manager who just wants to update an already well-developed mental model is searching for changes of certain constructs and interrelations between constructs in his model. He is able to easily specify the relevant areas and factors in the environment. By gathering information about the external environment, he monitors these determinants. Accord-

Table 1. Assignment of scanning modes to the stages of the managerial decision process

Managerial decision-making process	**Scanning modes by Aguilar (1967)**	**Scanning modes by Wilson (1997)**	**Scanning modes presented in this chapter**
1) Give attention to a problem or opportunity *(e.g., weak signal identification)*	(A) undirected viewing + (B) conditioned viewing	(a) passive attention + (b) passive search	Discovery
2) Collect information *(mostly external ES)*	(B) conditioned viewing + (C) informal search	(b) passive search + (c) active search	Expansion
3) Develop an array of options/alternatives *(shifting to internal ES)*	(D) formal search	(d) ongoing search	Monitoring
4) Assess and evaluate alternatives or options using expected costs and benefits *(Combining information from internal and external ES)*	(D) formal search	(d) ongoing search	Monitoring
5) Select alternative *(Evaluating and utilizing already combined information from internal and external ES)*	(D) formal search	(d) ongoing search	Monitoring

ingly, we refer to this information-gathering activity as *monitoring*. Since the organizations' resources as well as previously processed knowledge and all experiences accumulated within the organization are relevant for the development of options and alternatives, a shift in attention from external to internal ES is recommended in this stage of the decision process.

These categories of scanning behavior can be correlated to each other and assigned to the five stages of the decision-making process discussed earlier:

Practitioners can use the category distribution illustrated in Table 1 to choose the corresponding scanning mode for a managerial decision problem at hand. Of course, this topology is not exclusive, but rather denotes the main modes of scanning behavior for each stage. Referring to the managerial decision-making process presented above, each stage is assigned to at least one stage of mental model development. Therefore, the managers' mental models constitute a bridge between information searching and decision-making processes. The question of which scanning behavior is the best choice is strongly related with the perception of the environment as well as the already gained mental model of the relevant information environment. If substantial knowledge about a certain problem has already been obtained, *monitoring* turns out to be appropriate; if a rather new phenomenon is realized that cannot be consistently integrated or explained with the existing mental model, *expansion* seems to be the appropriate searching behavior. *Discovery* can be seen as augmenting the mental model with newly discovered information that is not necessarily important for tasks at hand, but could turn out to be significant in future tasks.

Pawar and Sharda (1997) discuss the relationship between the aforementioned scanning modes and corresponding Internet utilities. When conducting discovery activities, lists, Web catalogs (such as those provided by Yahoo), newsgroups and search engines are helpful in supporting ES activities. In particular, the integration of advanced functions in commercial Web services like Google and Ask Jeeves, such as the automatic identification of similar sites, supports search processes in the Internet for up-and-coming weak signals. In the modes of expansion and monitoring, further Web utilities, such as FTP servers, are helpful extensions in information seeking. Moreover, the "outsourcing" of information collection activities by using commercial online databases such as Lexis-Nexis, Dow Jones or Dialog is found to be supportive in ES. Chen et al. (2002) assert that these online databases are among the main sources for CI professionals.

With increasing understanding of new phenomena in the business environment—which is a basic premise for expansion and, especially, monitoring—search engines have become more and more expedient support tools because search queries can be conducted and varied based on the already elaborated, existing mental model of the manager.

Computer Systems Used to Aid the Scanning Process

Even without the use of intelligent systems, CEOs search regularly for information on the WWW (Tan & Arnott, 1999). Nowadays, the Internet provides several billion documents (Long & Suel, 2003) largely designated for cost-free use. Boncella (2003) gives an overview of the search engines and their use in the context of competitive intelligence. These search engines have several drawbacks. A search engine only proposes simple links that have to be followed manually. Also, these search engines frequently provide too many irrelevant responses. Fine-tuning or the use of advanced search engines takes time and requires special knowledge. Information systems can absorb redundancies in the information space, structure the information search and filter the information available in the information environment (Myers, 1999). One aim of technical developments in ES systems is to develop sensitive and context-dependent reductions of the massive information overload that makes up the environment in which modern businesses must operate. ES systems have to pare away almost all of the theoretically available information. Xu and Kaye (1995) recommend that the transition from data-overloaded systems to intelligence-dominated systems could be achieved by conceptualizing human-computer-based information filtering and processing as an essential part of ES systems. Although many studies have investigated the effects of multimedia systems, their impact on managerial decision-making is not well understood (Huang, 2003). Recently, in information retrieval literature, there has been a shift from technology-centered to human-centered approaches in developing new support tools to find, extract, understand and use information available from electronic information environments (Kerne & Smith, 2004). Mental models not only facilitate the link between managerial decision making and ES, but are also helpful in describing the tasks and information needs of computer support in ES. The central task to all of these processes is the adequate assessment and classification of information available from different sources. Nodine, Fowler, Ksiezyk, Taylor and Unruh (2000) indicate that the crucial process of information gathering is still done manually. They found that corresponding tools are used only 20% of the time to gather or analyze information.

Contrasting the limitations of the human mind and the complexity of modern business environments, computer systems are the most important utilities to supporting the ES process (Liu, 2001; Walters et al., 2003). However, especially in EIS, the support of ES activities is considered to be the least sophisticated part of decision support systems (Singh, Watson, & Watson, 2002). The inference and transfer of the user's information needs to software tools is often badly realized (Nitse et al., 2003). Seeley and Targett (1999) note that the introduction of new EIS frequently leads to reluctance in applying by chief executives. Since system developers assume that information needs can be easily elicited, the importance of developing and describing accurate information needs when designing EIS might be neglected. However, senior managers do not consider the identification of their information needs as their own responsibility. These obstacles are underscored in several studies that consistently identify the provision of timely, accurate and relevant information as the most critical problem for EIS (Rainer & Watson, 1995).

The framework developed herein explicitly addresses this main challenge. The interaction with the two other subsystems turns out to be useful in overcoming contemporary deficits in computer support systems. A successful system must strongly integrate concepts and limitations of managerial thinking and decision making that can be represented in mental models. A sound understanding of the user's way of thinking and the underlying information needs allows a customization that will increase the usability of the system. Again, empirical studies highlight these shortcomings. According to Wright et al. (2002), information overload and timely retrieval of information are stated as the most common problems in information gathering. Consequently, most of the existing software tools are still insufficient because of not fitting to the cognitive, structural and technological needs outlined in the framework above. To clarify these drawbacks, we will discuss two recent approaches to computer support for ES on the WWW—MasterScan and CI Spider. In line with the definitions of ES presented above, we separate ES software tools from standard CI software to facilitate a more complete and accurate comparison. Readers interested in a review of recent CI software tools are referred to Fuld and Company (2003). The two computer systems that claim to facilitate ES activities are described below. MasterScan, developed by Liu (1998), is a prototypic software agent that exemplarily executes scanning tasks for the pulp and paper industry. This system visits previously defined Web pages and gathers relevant information from these sources. The MasterScan is just able to extract information from pre-selected sources by comparing the content of these Web sites with the results from previous visits. Following the definition of scanning behavior suggested by Wilson (1997), the system only supports ongoing search activities. Therefore, it is primarily a *monitoring* tool unable to browse for new sources and detect information that is weak in the sense that basic ideas and concepts about this data have not yet been elaborated.

In a more recent approach, Chen et al. (2002) developed a tool for competitive intelligence on the Web that is also based on software agent technology. The CI Spider tries to avoid the principal shortcomings of classical search engines by generating its own structure for the retrieved documents and displaying them in a two-dimensional chart "on the fly."

The user has to specify a starting URL and the keywords used to evaluate the links and the documents found by the spider. Although the functionality of the CI Spider exceeds the well-known search engines, the user still must have a rather complete picture of the topics he or she wants to scan or monitor on the Web.

Although the development of appropriate tools is still in progress, some shortcomings can be outlined. Both of the aforementioned systems facilitate only the scanning modes of *monitoring* and—to some extent—*expansion*. The third mode of scanning behavior, *discovery*, is still not supported. This mode is crucial for detecting changes in the business environment and provides a trigger for the whole strategic decision-making process. While bad information quality can seriously harm the decision-making process, the total ignorance of future developments that are not even considered as problems (or opportunities) can lead to even more disastrous effects on business performance. The task of internal ES as introduced in Definition 2 is not supported at all by the aforementioned tools.

Undoubtedly, the task of discovering crucial developments in the external environment is challenging. The main reasons for the still missing link to *discovery* are rooted in the restricted understanding of human information-seeking processes and its appropriate transfer to mathematical models that can be implemented on computer systems. In the remainder of this chapter, we will present the IFT as a mathematical approach to model human information-seeking behavior and combine it with the detection of weak signals.

Information Foraging Theory

Basic Principles of IFT

To outline an approach that simultaneously deals with the three constitutive subsystems (stages of the human decision-making process, modes of searching in this information environment and computer systems used to aid the scanning process) as discussed, we draw on the IFT first introduced by Sandstrom (1994). IFT is a model that takes the characteristics of the virtual information environment into account, explicitly includes the limited information capacity of humans and facilitates a mathematical reproduction and handling of these problems in ES. Consequently, IFT is a suitable vehicle to overcome the obstacles emerging from the interdependence of the three subsystems and, thus, makes an ideal vehicle for autonomous ES on the WWW.

IFT models the forager's behavior while trying to deal with the constraints given in the information environment as well as its own limited capacity of information processing. The basic model of information foraging is based on the Patch and Prey Model of Optimal Foraging Theory, which assumes that information is structured in patches (describing the spatial neighborhood of information sources) and the forager has to decide which patches should be visited for which amount of time (Pirolli & Card, 1999; Stephens & Krebs, 1986). The forager has to cope with two basic decision problems: First, he or she is unable to access all information sources, so the forager has to select the most valuable sources of information he or she is able to handle in a given time. In analogy to the Optimal Foraging Theory, Pirolli and Card (1999) refer to this selection as *information diet*. The basic principles of choosing this diet will be discussed later.

Second, the forager has to assess which information sources he or she wants to access. Imperfect information is used to decide which paths through the information environment should to be followed; for example, which documents (information representations) should be selected. The forager uses proximal cues to assess profitability and the prevalence of information sources and their representations. This imperfect perception of the value, cost or access path of information is labeled as *information scent*.

The Model

The construction of the optimal *information diet* is modeled by the heuristic outlined in the following. IFT states that the behavior of information foragers follows the maximization of the rate of gain of valuable information per time unit cost (Pirolli & Card, 1999):

$$\max\ R = \frac{G}{B+T} \qquad (1)$$

where R is the ratio between the total net amount of valuable information gained, G, and the total time spent on searching this information; for example, the cumulative time spent on switching from one information source to the next, B, and the total time spent on extracting and handling the relevant information from the information representations, T.

Assuming that a set of I information sources is available in the business environment that can be separated into two patches, h=1, 2, with h=1 referring to information sources (documents in the latter) in the external environment and h=2 denoting documents in the internal environment. The average ratio of gain of information from the information environment h can be considered as follows[1]:

$$R(I_h) = \frac{\sum_{i=1}^{|I_h|} \lambda_h \cdot g_{hi}}{1 + \sum_{i=1}^{|I_h|} \lambda_h \cdot t_{hi}} \quad \forall\ h \qquad \text{with} \qquad T = \sum_{h=1}^{H} \sum_{i=1}^{I_h} t_{hi} \qquad (2)$$

where g_{hi} is the gain of document $d_{hi} \in I_h$ extracted in time t_{hi} and $\lambda_h = 1/b_h$ is the encounter rate (e.g., prevalence) of relevant documents in environment h derived from the average time needed to encounter a document (with $B = \sum_{h=1}^{2} \sum_{i=1}^{|I_h|} b_h$, in case of exploiting all documents in I). It should be noted that the gain of documents might differ between the environments because the documents might differ with respect to length, structure and so forth, and last but not least, relevance. The profitability π_{hi} of document d_{hi} is given by:

$$\pi_{hi} = \frac{g_{hi}}{t_{hi}} \qquad (h = 1, 2, \quad i = 1, ..., I_h) \tag{3}$$

Construction of an Optimal Information Diet

The following algorithm can be used to determine the rate-maximizing subset of information sources given in information environments h=1,2 that should be selected and extracted by the forager (Pirolli & Card, 1999; Stephens & Krebs, 1986):

1. Rank the information sources by their information profitability. For simplicity of presentation, let the index i be ordered such that:

   $$\pi_{hi} > \pi_{h(i+1)} \quad (h = 1, 2,\ i = 1, ..., I_h)$$

2. Add information sources to the diet until the rate of gain of information for a diet of the top n information sources is greater than the profitability of the n + 1 information source:

   $$R(n) = \frac{\sum_{h=1}^{2} \sum_{i=1}^{n_{h'}} \lambda_{h'} \cdot g_{h'i}}{1 + \sum_{h'=1}^{2} \sum_{i=1}^{n} \lambda_{h'} \cdot t_{h'i}} > \frac{g_{h(n+1)}}{t_{h(n+1)}} = \pi_{h(n+1)} \quad (h' = 1,2), \text{ with } n = n_1 + n_2 \tag{4}$$

   Equation 4 provides a criterion for the selection from an ongoing stream of information and, therefore, advises not only how to devote the limited attention to the external or internal environment scanning activities, but also gives clear advice on which documents or sources should be considered.

Accessing the Information Gain

The information gain of a document is appraised by means of its relevance in a given context. The relevance of information depends on the information needs directly connected to the manager's mental model. Referring to Rouse (2002), the value space of information is made up of the following three dimensions:

- **Usefulness:** the extent to which information represents the intentions of the user.
- **Usability:** the extent to which information can easily be assessed, digested and applied.
- **Urgency:** the extent to which information contributes to near-future aims of the user.

Due to the given information overload of the WWW, the relevance of a document is not evaluated by reading documents in their entirety, but rather by pre-estimating the value of a document through proximal cues. These proximal cues are singular language expressions, name of authors or location of the information source. Thus, we represent each document d_{hi} by means of an L-dimensional vector, where each dimension captures a language expression that occurs in the world. Fauconnier (1997) argues that a language expression does not have a meaning in itself, but rather has a meaning potential. The assessment of the *information scent* by means of language expressions that embody proximal cues is modeled by a spreading activation network.

According to Anderson (1990), the activation of a memory fed with a proximal cue should be the sum of the base-level activation for that stimulus plus the activation that spreads to it from elements in the current context. As a Bayesian prediction of the relevance of a language expression k, the following formula proposed by Anderson (1990) in the context of his well-known adaptive control of thought (ACT-R) theory is applied:

$$A_k = C_k + \sum_l W_l S_{kl} \tag{5}$$

with:

A_k: Association strength of term k
C_k: Base-level activation of term k
S_{kl}: Association strength of term l on element k in the current context
W_l: Base-level activation of term l

The base-level activation of different language terms varies due to the given mental model of the manager. Language expressions that refer to relevant concepts in the mental model of the manager ought to have high association strengths, whereas low strengths denote dissociated terms. The association strength of a proximal cue (language term or concept of the mental model) is computed with the help of the following three equations (Pirolli & Card, 1999):

$$C_k = \ln\left(\frac{p(k)}{p(\bar{k})}\psi\right) \forall\, k = 1, \ldots, K \tag{6}$$

$$W_l = \ln\left(\frac{p(l)}{p(\bar{l})}\psi\right)\forall l = 1,...,k-1,k+1,...,K \tag{7}$$

$$S_{kl} = \ln\left(\frac{p(l\,|\,k)}{p(l\,|\,\bar{k})}\psi\right) \quad \forall l \neq k \tag{8}$$

with *p(k)* and *p(l)* denoting the probabilities of language expressions *k* and *l* occurring in the world, while $p(\bar{k})$ and $p(\bar{l})$ reflect the probabilities that term *k* and *l* will not occur in the information environment. The posterior probabilities $p(k\,|\,l)$ and $p(k\,|\,\bar{l})$ denote the conditional probability of the occurrence of term *l* in the context of term *k* and the conditional probability of term *l* occurring in a context that does not contain word term *k*. The normalizing constant ψ is applied to yield positive values only.

The resulting *information scent* arising from the association strengths of language expressions that make up managers' mental models and occur in document d_{hi} is used to appraise the information gain of each document:

$$g_{hi} = \exp\left(\frac{\sum_{k\in(Q\cap d_{hi})} A_k}{Z}\right), \forall d_{hi} \in I\,, \tag{9}$$

where Z is a scaling factor that is estimated on an a priori characterization of the information environment (see Pirolli and Card (1999) for details). The set of relevant terms q is derived from the mental model of the manager. We denote this set of relevant terms as information structure. Scholz and Wagner (2005) show that this information structure is robust against serious contamination of irrelevant language expressions.

Proof-of-Concept Test

We implemented the above model in a prototypical scanning system to scrutinize its validity in the context of ES. Therefore, we selected 50 articles of the Reuters test text collection (Lewis, 1997), all of which refer to the domain of finance in various ways. We defined a typical scanning task. The task was to extract valuable information about up-and-coming general developments of financial markets. Due to globalization, Babbar and Rai (1993) argue that this domain is very important in ES. First, three experts were surveyed to elicit relevant concepts of their corresponding mental models helpful in dealing with this task. Subsequently, the three experts were asked to read each document in its entirety and evaluate the information gain by means of the Delphi method. The experts used a 12-point scale. Documents with high relevant information were given 12 points while documents containing no relevant information received 0 points. The

Figure 2. Distribution of experts' evaluation and information diet of the prototypical system

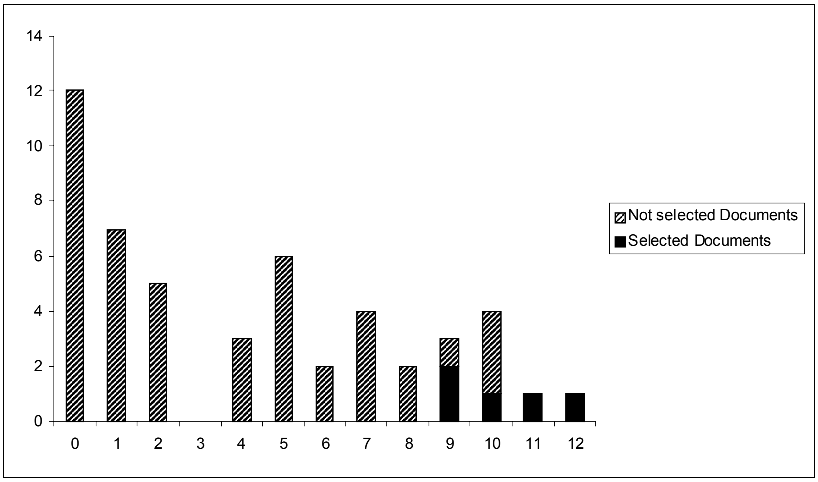
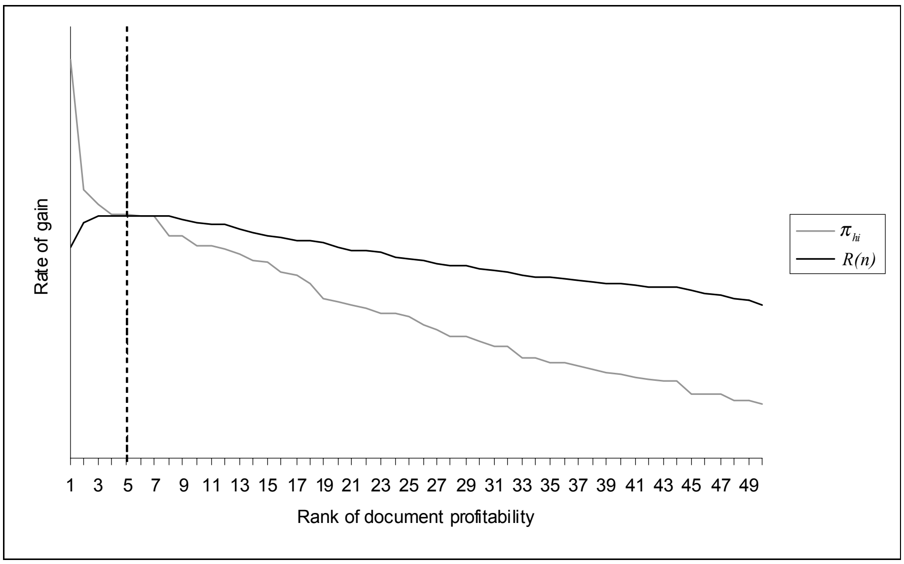


Figure 3. Relationship between profitability (π_{hi}) and rate of gain (R) for diet including items



average assessment of documents led to 4.1 points. The distribution of the experts' assessments is given in Figure 2.

The prototypical scanning system was instructed with the same task. The information structure of 129 language expressions was elicited from the experts' mental models. Figure 3 shows the computations of the profitability of the ordered 50 documents as well as the corresponding rate of gain as introduced in Equation 4. Function *R(n)*, which denotes the rate of gain for diet including items, increases as the diet is expanded up to five items and then starts to decrease slowly as additional items are added to the diet. Consequently, the optimal information diet consists of the five top-ranked documents only. It was found that this number is similar to the amount of documents selected by human experts confronted with the same task (Decker et al., 2005). In selecting five documents, the system yields an average performance of (9+9+10+11+12)/5 = 10.2 points (see Figure 2). While this result does not obtain the optimum average performance (which would have been (10+10+10+11+12)/5 = 10.6), it can be seen as a rather satisfying result. Thus, IFT proves to be able to use proximal cues to assess and select the relevance of documents in this ill-defined scanning task.

Conclusion and Managerial Implications

ES is found to be an overly complex task due to the spectrum of different subjects and perspectives. Starting from a distinction of external and internal ES, the weaknesses in current ES, BI and weak signal detection are explored with emphasis on digital resources available on the WWW. Linking these activities to the stages of the managerial decision-making process enables practitioners to choose a suitable sequence of information-gathering activities with respect to their individual situation. This may help overcome the problems of unsystematic ES processes prevailing in current business practices.

The Internet constitutes an ideal collection of resources to make up a well-elaborated mental representation of future changes. We argue that these mental models provide an expedient approach to understanding the shortcomings as well as the premises of promising ES activities. With respect to practitioners, it should be noted that new information has to be presented in familiar structures to enhance integration in already-existing mental models. Thus, the information-gathering activities must be adapted to the current knowledge infrastructure as well as the managerial decision problem at hand.

Scanning activities are done in different modes, which are related to the stages of the decision-making process as well as to the internal and external ES scopes. It turns out that the most crucial task in ES—the detection of new developments by means of weak signals identification—is not covered completely by already established typologies of scanning behavior modes. This also holds for current available ES software systems that support monitoring activities on the WWW. An additional drawback, particularly relevant from a practitioners' point of view, is the missing assessment of the information gained through documents monitored by these systems.

A remedy for this is introduced by a prototypic system based on the IFT. In a proof-of-concept test, the prototypic system shows promising performance in the identification of relevant information sources and significantly reduces the amount of information to be processed by humans. The most remarkable feature is the content-dependent ordering of sources combined with computing of the maximal number of documents to be studied by the managers. By considering information from sources arriving with different intensities, this approach offers an opportunity to balance internal and external ES with respect to the documents' content and the already-existing information structure. Rules of thumb are not needed anymore. In summary, it offers an operationalization of autonomous ES in virtual information environments, such as the WWW, but clearly has limitations. The current approach is restricted to written documents, unable to evaluate any kind of figures or numbers. Moreover, it is limited to information in written form—that is, verbal information cannot be considered. The next challenge is to evaluate the system proposed herein by managers in real-world ES tasks.

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Endnote

[1] For a complete derivation of this equation, see: Stephens and Krebs (1986) or Pirolli and Card (1999).

Section IV:

Inter-Organizational and Global Implications

Chapter XII

IT Outsourcing: Impacts and Challenges

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Abstract

This chapter provides both practitioner and academic insights into outsourcing. It begins with a review of the literature and practice of outsourcing, followed by a retrospect of its developments since the 1960s, up to present-day emergent trends such as best/smart-sourcing, rural-sourcing and business application grids. Recent legal developments are highlighted, along with their corresponding impacts. Outsourcing decisions tend to focus solely on the short-term benefits of cost reduction and service level improvement and, hence, often lack strategic direction, thus indicating the need for strategic management frameworks in the decision process. This chapter introduces a generic framework for such decision-making and highlights other strategic frameworks developed by researchers. The chapter then concludes by summarizing suggested action points that enable both clients and service providers to best exploit the recent developments in outsourcing, in order to maintain the strategic edge in an increasingly complex and competitive business environment.

Introduction

The term outsourcing was coined in the 1970s to describe an agreement where an external organization provides services for a client that were previously carried out internally (Cap Gemini Ernst & Young, 2003). Initially, an arrangement of necessity, and later, a major cost-cutting move, it has evolved to become a mainstream strategy in a myriad of industries.

The increasingly competitive markets have introduced further pressures to cut costs, and companies are now more inclined than ever to utilize outsourcing, which has spurred its continued growth over the past years. Reports of outsourcing mega-deals (i.e., deals with total contract value of $1 billion or more) are increasingly commonplace, indicating the large scale of the outsourcing market. In 2003 alone, a record number of 15 mega-deals were awarded out of the 78 mega-deals publicly announced since that of Kodak Eastman back in 1989. One of the most high-profile of these is the United Kingdom (UK) Inland Revenue organization's mega-deal with the Cap Gemini Ernst & Young consortium, involving what was reported to be the world's largest transfer of 3,500 staff in a 10-year deal worth $7-9 billion (Cullen, 2003).

Recent statistics indicate that outsourcing is now a $180 billion industry (Anderson, 2004), and Information Technology Outsourcing (ITO) now accounts for one-third of global IT spending (Cap Gemini Ernst & Young, 2003). The promise of massive cost savings in the region of millions is driving the trend towards more outsourcing mega-deals. However, there have been a number of failed high-profile cases, which raises questions about the potential risks involved, particularly the lack of flexibility of long-term contracts. This was highlighted by the collapse of the Bank of Scotland's (BoS) 10-year $1.2 billion mega-deal with IBM, which was indicated to have failed because of its inflexibility to accommodate the business change following the merger of BoS with Halifax ("Bank bins £700m IBM deal," 2002).

Another trend that has been in the media spotlight is that of Offshore Outsourcing, which has gained considerable negative publicity because of the controversial connotation of job losses to the client country and the potential of long-term adverse effects to its economy. Currently, 50% of all phone calls to the U.K. National Rail Enquiries are handled by operators in India (Nash, 2003); also, IBM plans to move up to 4,700 programming jobs overseas to save costs, and HSBC will transfer 4,000 customer service jobs to Asia by the end of 2005. These statistics illustrate the extent of the trend towards Offshore Outsourcing, which is becoming increasingly prevalent in various industries; however, there are risks associated with loss of control and confidentiality issues. In 2003, this was highlighted in a case involving medical transcription, a commonly outsourced process for the medical industry, which the University of California San Francisco (UCSF) Medical Centre had been outsourcing for the past 20 years. Unknown to them, part of the outsourced work was subcontracted to a service provider in Texas, which, without the knowledge of anyone, further subcontracted the work to a physician in Pakistan (Bagby, 2003). The arrangement went without a hitch for 18 months, until the company in Texas refused to pay the physician in Pakistan, who threatened to post the patient medical histories on the Internet if not given the back pay, thereby infringing privacy and confidentiality laws. Although short of total failure in the sense that the outsourcing arrangement was salvaged following private financial settlement with the Pakistani physician, the incident illustrates the potential risks of outsourcing.

The decision by businesses to outsource raises a number of critical issues for corporate management (Currie, 1995). To achieve success in outsourcing, companies will need to be aware of the emergent trends, understand their potential impact and utilize framework techniques for strategic management.

Background

Outsourcing is defined by Griffiths (2001) as the strategic use of outside resources to perform activities traditionally handled by internal staff and resources. Laudon and Laudon (2000) define it as the process of turning over an organization's computer operations center, telecommunications networks or application development to external vendors. Incorporating the common theme between these and other slightly different definitions, the authors define outsourcing as the third-party management of assets and resources at a required performance standard pre-defined by negotiation.

Theorists such as Lonsdale and Cox (2000) perceive outsourcing as one way in which the boundary of a firm (i.e., company) can be adjusted in response to changing economic pressures. This is based on the theory proposed by Ronald Coase in his article "The Nature of a Firm," which suggested that the motivation behind adoption of their chosen structure is related to the trade-off between the costs of accessing the market and the problem of diseconomies of scale (Coase, 1937). In recent years, outsourcing decision-makers have adopted the concept of core competence from the much publicized article "The Core Competence of the Corporation" by Hamel and Prahalad (1990), which advocates that firms should focus solely on their core business and consider outsourcing the rest.

The exact history of outsourcing is somewhat vague: Although documented instances of its use first appeared in the 1950s, outsourcing in the form of subcontracting of work was indicated to have begun as early as the 1800s. In the early years of American history, the making of clipper ships' sails and covered wagons' covers was outsourced to workers in Scotland, with raw materials imported from India (Kelly, 2004). It was purported that by the 1830s, England's textile industry became so efficient that eventually Indian manufacturers were unable to compete, and the work was outsourced to England.

Within the U.K., outsourcing was introduced in the 1980s as a public sector management tool to provide a means to cut operational cost, reduce the risk of union strikes and downsize blue-collar workforces. This began primarily on the local government level, then progressed to the central government level in the 1990s, following the government white paper "Competing for quality: buying better public services" by the HM Treasury (1991).

Developments of IT Outsourcing

Origins

Although outsourcing is often marketed as the latest strategic management tool, it is in fact the renaissance of a practice that has existed for decades. There are conflicting accounts of when outsourcing first begun, but the first documented practice of outsourcing appeared to be in the area of information systems when General Electric Corp. contracted with Arthur Andersen and Univac in 1954 (Klepper & Jones, 1998).

The 1960s

In the 1960s, outsourcing took the form primarily as a facilities management service (Kelter & Walstrom, 1993; Teng, Cheong, & Grover, 1995). During this time period, computing usually involved the mainframe in a centralized computing model under which numerous users shared the same computer (Currie, Desai, Khan, Wang, & Weerakkody, 2003). As computing capability was very expensive, only the larger companies could afford such mainframes. Smaller companies often had to "piggy-back" their computing needs onto that of larger companies in return for a monetary fee. This arrangement, which involved sharing of the computer process time of the mainframes, was then known as "time-sharing."

The 1970s

Prior to the 1970s, companies who were clients of major hardware (e.g., mainframes) manufacturers had access to a library of software that was bundled in the cost of the hardware (Software History Center, 2002), which ranged from the computer's operating systems to various utility programs. In the 1970s, generic software from such bundled sources was deemed unable to meet specific needs unique to individual companies, and hence, the need for customized software arose.

Development of such customized software in-house was inherently expensive, particularly for smaller companies, due to the skill sets required and the additional personnel that would have to be hired to provide the required expertise. Given the high costs associated with such software development, it was often contracted out, and hence, outsourcing in the form of contract of programming was prevalent in the 1970s.

The 1980s

By the 1980s, the cost of computing capability had begun to plummet, due to the arrival of low-cost versions of mini-computers and then Personal Computers (Lee, Huynh, Chi-wai, & Pi, 2000). With reference to the market-standard measurements of Million

Instructions Per Second (MIPS), the cost for 1 MIPS has fallen sharply from $1,000 in 1975 to $250 in 1980—a steep 75% drop.

Consequently, the cost of maintaining in-house computing facilities became more financially feasible and, as a result, companies began to bring previously outsourced services in-house. Retaining services in-house continued in the mid-1980s on the grounds of the supposedly better internal control and reservations of "opening up" the company to outsiders.

However, the large-scale outsourcing contract between Kodak Eastman and IBM in 1989 (Currie et al., 2003) sparked off a massive bandwagon effect (Lacity & Hirschheim, 1993). In retrospect, this trigger is possibly the ground-breaking deal that brought outsourcing into the limelight, and is often quoted as the first instance in which outsourcing was defined as a formal strategy.

The 1990s

The early 1990s were characterized by renewed interest in outsourcing (Lee et al., 2000) and strategic use of outsourcing was the focus. Within this time period, outsourcing was utilized for two main purposes.

First, outsourcing was utilized to force downsizing within companies in order to keep them "lean and mean" for competitive advantage. Second, outsourcing was utilized to upgrade legacy systems operating on 3rd Generation Language (3GL) to 4th Generation Language (4GL). Due to limited in-house resources, companies often encountered challenges while attempting to upgrade the existing applications themselves. As such, many companies had to resort to outsourcing the upgrade to a third party, which was considered to be better equipped in terms of technical skill sets and human resources, in order to ensure a smooth transition.

In 1999, there was an increased uptake of on-site facilities management and selective outsourcing, primarily in areas associated with the Y2K problem (i.e., millennium bug). This took form in the use of contracting staff and involved early applications of Offshore Outsourcing, primarily to India.

The 2000s

Transformational use has been the main focus of outsourcing in recent years, particularly in the areas of Business Process Outsourcing and Offshore Outsourcing.

Business Process Outsourcing has been utilized to redefine the company's operating model and structure. Administrative, transactional and similar work have been shifted to third parties with the aim of reaping benefits such as cost savings, better access to emerging technology and the freeing of internal staff from administrative trivia to focus on strategic issues more vital to the company. It is now seen as a service where total, defined business processes are given to expert service providers who manage the process and ensure the total integration between outsourced business processes and in-house processes (Kruse & Berry, 2004).

Globalization, driven by agreements such as the North American Free Trade Agreement (NAFTA) and the liberalization of economies like those of China and India, increased companies' propensity to outsource overseas to low labor-cost countries (Namasivayam, 2004). This form of outsourcing, known as Offshore Outsourcing, is increasingly popular with companies seeking the means to lower costs and maintain a round-the-clock availability in their quest for higher efficiency. Predictions from Forrester Research Inc. (Engardio, Bernstein, & Kripalani, 2003) indicate that 1 million jobs in the United States (U.S.) will be moved offshore by 2010.

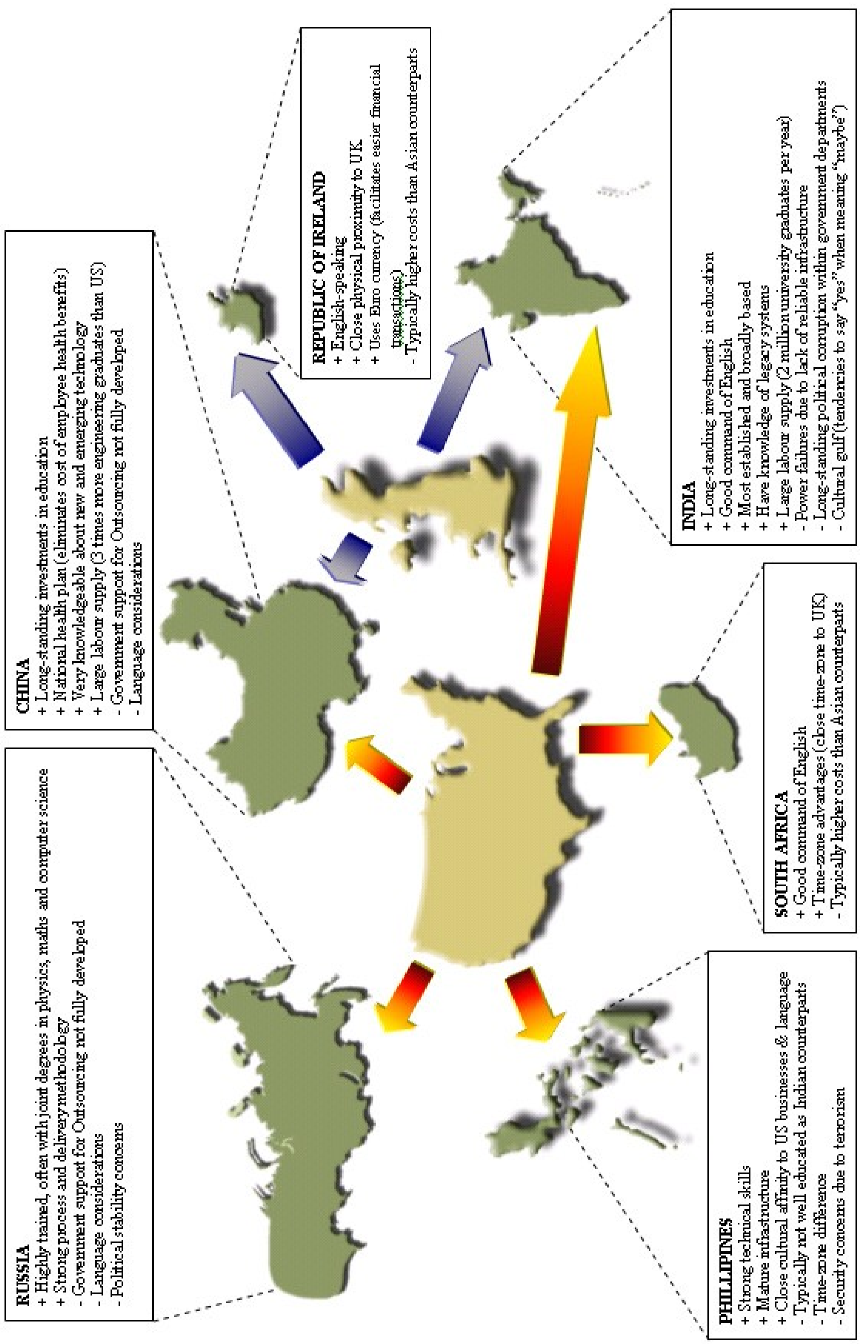
Figure 1 illustrates the key locations being considered for Offshore Outsourcing and provides a quick summary of each country's advantages and risks. India is currently one of the most popular locations for Offshore Outsourcing due to the strong government support for outsourcing and the abundance of low-cost English-speaking workers who are highly skilled. Additionally, the difference in time zone from Western markets makes it an ideal choice for providing round-the-clock coverage. However, there are concerns about power failures, due to the lack of a reliable infrastructure, which are highly disruptive to computer-based operations.

China is predicted by industry experts to be a close competitor to India in the near future (Furniss, 2003), largely due to the liberalization of laws and government policies brought on by its membership into the World Trade Organization. Its political leaders have taken note of the importance of the technical education in India and begun to invest heavily on academia to raise its level of technical competence. China is also regarded because of low labor costs due to its large untapped supply, making it a more favorable location in the future for companies seeking the lowest costs. However, government support for outsourcing is yet to be fully developed and language considerations are still a main concern for companies planning to outsource to China.

Emergent markets that companies have begun to consider include Russia, South Africa and the Philippines. Russia is noticed for its availability of joint-degree graduates with a strong delivery methodology approach; however, there are concerns regarding language skills and political stability. South Africa, which is indicated to be a niche provider of insurance policy administration, has the key advantages of having a good command of English and a time zone close to the UK, but is unable to compete with its Asian counterparts in terms of labor costs and communication costs at present. The Philippines is noted for its strong technical skills and mature infrastructure, along with its close cultural affinity to U.S. businesses and language, but there are security concerns due to the perceived terrorism threat in the region.

Central Europe is beginning to catch up in Business Process Outsourcing, despite having entered the market later than India and China. Although it is less favorable in terms of labor costs, typically three to five times that of India and China, Central Europe has the advantages of a diverse language pool (French, Spanish, etc.) and cultural affinity to Western markets. As such, it is expected that outsourcing will be a growth industry for Central Europe, particularly new members of the European Union, such as Poland and Czech Republic.

Figure 1. Advantages and risks of key offshore outsourcing locations



Types of Outsourcing

Willcocks, Feeny and Islei (1997) distinguished between four main types of outsourcing, namely Total Outsourcing, Total Insourcing, Selective Outsourcing and De Facto Outsourcing. Ho, Atkins, and Eardley (2004) extended the distinction to six types, with the inclusion of Offshore Outsourcing and Business Process Outsourcing. This has been further extended to nine types, taking into account Business Transformational Outsourcing, Retro-sourcing and Rural-sourcing from literature reviews, all of which are outlined as follows:

- **Total Outsourcing** refers to the decision to transfer the provision and management of at least 80% of services to the external service providers.
- **Total Insourcing** refers to the decision to retain the provision and management of at least 80% of services internally after a reasoned evaluation of the external service provider market.
- **Selective Outsourcing** refers to the decision to source selected services from external service providers while still providing between 20-80% (typically 24%) of services internally.
- **De Facto Outsourcing (Insourcing)** refers to the exclusive use of internal resources to provide services, which arises from historical precedent rather than a reasoned evaluation of the external service provider market.
- **Offshore Outsourcing** refers to the decision to transfer the provision and management of services to external service providers outside of the client organization's home country and also on cruise ships off territorial waters.
- **Business Process Outsourcing** refers to the decision to transfer selected areas of the client organization's repeated core and non-core business processes to external service providers; for example, financial statement analysis and statutory reporting.
- **Business Transformational Outsourcing** refers to a type of relationship that involves both Information Technology Outsourcing and Business Process Outsourcing. While traditional use of outsourcing is to offload non-core activities and leverage economies of scale, Business Transformational Outsourcing is instead utilized to gain strategic competitive advantage on an enterprise-wide basis and share risks in innovating to enhance business performance.
- **Retro-sourcing** refers to a cyclic relationship where an offshore service provider outsources some degree of services back to the client organization's home country, typically by the creation of a business division sometimes misclassified as "Insourcing." Protagonists of Retro-sourcing claim that it is a positive trend that results in job creation, while antagonists claim that it is merely "outsourcing in sheep's clothing" (Reisman, 2004).
- **Rural-sourcing** refers to an obscure form of Outsourcing in which the provision and management of services are transferred to rural regions of the client organization's home country. The concept of retaining jobs onshore while benefit-

ing rural communities in the process presents opportunities for companies to project a positive public image; hence, Rural-sourcing is expected to be an increasingly viable alternative to Offshore Outsourcing.

Advantages of Outsourcing

Cost Reduction

Companies that maintain all services in-house may incur vastly higher research, development, making and deployment costs, which can severely reduce their overall competitive advantage. Outsourcing can be utilized to exploit the lower cost base of external service providers, which allows for reduction in operating costs (Namasivayam, 2004) and capitalization (Kruse & Berry, 2004), allowing additional finances to be freed for use in other areas of strategic importance. Typical cost reductions are in the region of 20% to 40% (Davison, 2004; Namasivayam, 2004), primarily by labor cost arbitrage, although some literature have indicated cost reductions of up to 70% (Synergy Infotech, 2004).

Access to Specialist Resources

World-class service providers amalgamate expertise by working with multiple clients facing similar challenges, and make extensive investments in both technological and human resources. Consequently, the careful selection of a service provider with cutting-edge technologies and skills can provide access to world-class capabilities and specialist resources (Kruse & Berry, 2004; Namasivayam, 2004), which can aid in areas such as reducing the risks of technology obsolescence and overtaking competitors on the technological front.

Improved Focus

Outsourcing allows a company to focus on its core business by offloading operational aspects to service providers with expertise in their respective fields. The ability to "cherry-pick" a variety of services from leading service providers enables the company to optimize its value chain (Sloper, 2004), focus its resources on meeting client needs and improve contribution towards overall business objectives.

Subcontracting of Workload

Each company has limits on the resources available to it; thus, outsourcing can be a particularly viable option in situations where a company's internal human resources are stretched. By diverting certain components of the existing workload out to external service providers, internal resources can be allocated to business objectives of strategic importance with the aim of achieving higher efficiency and competitive advantage.

Better Risk Management

Risks are inherent to almost any business decision (Aubert, Dussault, Patry, & Rivard, 1999) due to ever-changing market competition, government legislations, financial conditions and technologies. It can be both taxing and costly to be fully market-aware of all risk resulting from such economical, political, financial and technical issues. Outsourcing allows companies to exploit the resources and expertise of specialists, thus resulting in better risk management compared to internal handling.

Risks of Outsourcing

Loss of Organizational Competencies (Tacit Knowledge Loss)

One commonly cited risk associated with the use of outsourcing is the loss of organizational competencies, which increases the level of dependence on external service providers. As outsourcing deals often involve transfer of human resources, the internal expertise available in a company may be significantly reduced, hence hampering its ability to maintain competitive advantage and to innovate (Earl, 1996). To reduce the loss of internal expertise, which in turn impacts organizational competencies, companies should conduct a thorough evaluation of all staff, prior to any transition, to identify those that need to be retained for required skill sets.

Reduction in Quality of Service (Service Debasement)

Service debasement refers to any reduction in the quality of services received by a client (Aubert, Patry, & Rivard, 1998). Service quality may decline through the contract or may just fall below agreed-upon levels (Bahli & Rivard, 2003). This can be curtailed by the effective use of Service Level Agreements. For successful implementation, companies will need to have the ability to evaluate the performance of outsourced services, and hence, require some technical knowledge of the respective fields.

Cost Escalation

Cost escalation can sometimes occur from unforeseen expenses that result in an overrun of originally contracted estimates (Bahli & Rivard, 2003). This covers a broad range of costs, including the development and maintenance of an exchange relationship (i.e., outsourcing relationship), monitoring exchange behavior (i.e., service level monitoring) and guarding against opportunism (Williamson, 1985). This can be mitigated by a comprehensive financial analysis prior to outsourcing and the use of definitive Service Level Agreements that clearly indicate the financial basis and conditions of the outsourcing arrangement.

Lock-In

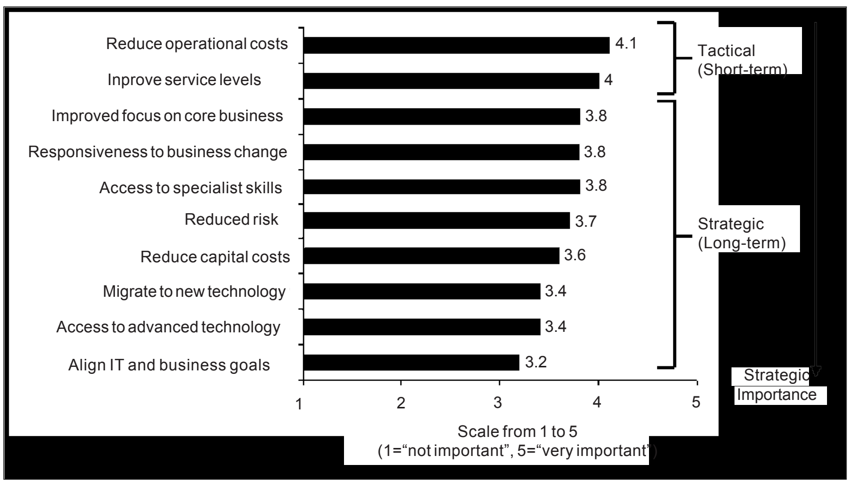
Lock-in is a risk that often results as an extension of the loss of organizational competencies. A lock-in situation may occur in instances where a company has not retained sufficient in-house expertise or when there are relatively few service providers capable of offering the breadth and depth of services required (Bahli & Rivard, 2003). Contractual and practical safeguards are necessary to militate against lock-in (Sloper, 2004), which include strategic partnerships, based on risk sharing and mutual goals, and dual sourcing strategies involving the use of multiple service providers (Kern, Willcocks, & Van Heck, 2002). Some companies, such as British Aerospace, have deliberately maintained control of strategic IT functions to safeguard against the risk of lock-in.

Strategic Frameworks

The increasing complexity of outsourcing, as shown from a number of high-profile failures (Bagby, 2003; Cullen, 2003), highlights the need for strategic implications to be considered; consequently, tools to support this strategy have to be formulated and utilized.

Figure 2 illustrates the key reasons for outsourcing as identified by a study in 2004 conducted by PMP Research. The study surveyed 100 organizations, comprised of approximately 25% from the public sector and 75% from various elements of the private sector, regarding their view and opinions on the use of outsourcing (Mills, 2004). The two main reasons identified are to reduce operational costs and to improve service levels, both of which are tactical (i.e., short-term) in nature, which hints at the potential lack of strategic considerations in some instances of outsourcing decision-making.

Figure 2. Key reasons for outsourcing



Although there are several advantages associated with outsourcing, like any other business move, there is a degree of risk involved; for example, loss of control and privacy issues in the case of Offshore Outsourcing. This underscores the need for a strategic perspective to outsourcing decision-making, rather than a tactical perspective that focuses primarily on short-term benefits.

Generic Framework

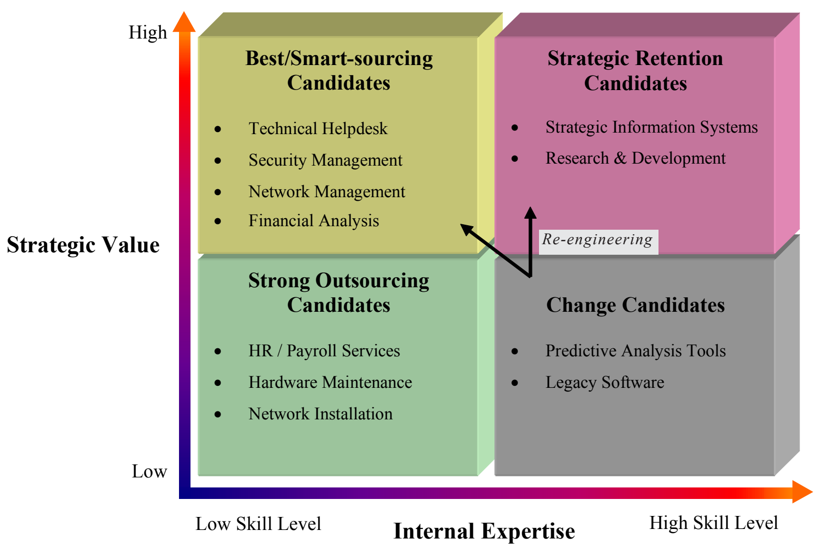
Figure 3 illustrates a generic framework for outsourcing decision-making, which allows for analysis of strategic value of the evaluated function against internal expertise (i.e., in-house) available in the company.

The framework provides for classification into one of four possible quadrants, namely:

Best/Smart-Sourcing Candidates

Functions classified under this quadrant are high in strategic value but low in internal expertise. These functions should be subject to a reasoned capability evaluation from both internal departments and external service providers to determine its viability for outsourcing. This selection process, which determines the "best" service provider, in terms of cost effectiveness and process efficiency, is known as "best/smart-sourcing." Examples of such functions include technical help-desk (e.g., troubleshooting and end user support) and security management (e.g., anti-virus updates and network security).

Figure 3. Generic framework for outsourcing decision-making



Strategic Retention Candidates

Functions classified under this quadrant are high in both strategic value and internal expertise. These functions should be retained in-house, as it protects the company's ability for rapid innovation along with its expertise in the domain. However, in some instances, companies are known to utilize consultants or expert advisors from external service providers to boost or enhance the existing internal capabilities. Examples of such functions are research and development fields, and applications that have been identified as Strategic Information Systems (SIS); that is, they are aligned with business objectives and have significant impact on organizational performance. Some of the classic examples could be American Airlines' (AA) SABRE System, Baxter Healthcare International's "stockless inventory" system, and Wal-Mart's "continuous replenishment" Customer Relationship Management (CRM) system (Laudon & Laudon, 2000).

Strong Outsourcing Candidates

Functions classified under this quadrant are low in both strategic value and internal expertise. These functions are considered to contribute little value to the core business and are limited in terms of internal expertise, hence are strong potentials for outsourcing. Traditional examples of such functions are payroll systems and hardware maintenance. However, it is important to note the assessment of value contributed to core business may differ for individual companies; thus, each function should be examined in the appropriate business context instead of a generalization. For example, a security company may establish that their staff's work attitude is linked to being paid efficiently, and thus view payroll as a vital component that should be retained in-house, hence contradicting the traditional concept of payroll as a strong candidate for outsourcing.

Change Candidates

Functions classified under this quadrant are low in strategic value but high in internal expertise. In an ideal business setting, such functions are not supposed to exist, but they sometimes do exist in real-world business settings due to the isolation of IT functions from business functions that leads to separate agendas; that is, the lack of strategic alignment of IT with business objectives. These functions could be specialist-developed products looking for a business purpose or products that are well in advance of current business needs.

These functions should be mitigated within the portfolio, either by elimination (possibly by means of outsourcing) or process re-engineering (possibly for development into strategic applications to be retained in-house). An example of such functions is predictive analysis tools, often developed by internal staff with high skill levels, which apply sophisticated analysis techniques to enterprise data. Although these tools are technically advanced, they produce predictive analysis models that have a low strategic value when utilized alone. However, when such predictive analysis models are combined with organizational business knowledge, they can provide insight into critical issues, such as fraud detection, customer retention and cross-selling strategies. In these instances, the predictive analysis tools are "change candidates" ideal for process re-engineering to develop them into "strategic retention candidates."

Other Frameworks

In addition to the generic framework presented, Ho et al. (2004) identified a number of strategic frameworks for outsourcing decision-making, which are briefly outlined in Table 1.

Table 1. Strategic frameworks for outsourcing decision-making

Willcocks Frameworks *(Willcocks et al., 1997)*	❖ Matrix Analysis (Strategic Grid/Boston Matrix) ❖ Empirically derived frameworks ❖ Focused on critical factors ❖ Set of three frameworks • Business Matrix • Economic Matrix • Technical Matrix
Yang-Huang Decision Model *(Yang and Huang, 2000)*	❖ Utilizes Analytic Hierarchy Process method ❖ Hierarchical format ❖ Works on principle of decomposing complex problem into sub-problems
De Looff Framework *(De Looff, 1995)*	❖ Descriptive framework ❖ Provides for systematic description of outsourcing options ❖ In the form of a checklist
Perry Matrix Framework *(Perry, Stott and Smallwood, 1993)*	❖ Matrix Analysis (Strategic Grid/Boston Matrix) ❖ Based on concept of Unit Competitive Advantage ❖ Analyzes a function's abilities to value-add
Systems Audit Grid *(Earl, 1989)*	❖ Matrix Analysis (Strategic Grid/Boston Matrix) ❖ Involves an information systems audit ❖ Incorporates both the business-user perspective and technical-specialist perspective
Cox Methodology *(Cox, 1996)*	❖ Based on Relational Competence Analysis ❖ Involves assessment of asset specificity
McIvor Framework *(McIvor, 2000)*	❖ Integrates key theories, such as core competency thinking, value chain perspectives and supply base influences ❖ Involves core activity definition, value chain analysis, total cost analysis and relationship analysis
Four Outsourcing Relationship Type (FORT) Framework *(Kishore, Nam, Rao, Rajagopalan and Chaudbury, 2003)*	❖ Matrix Analysis (Strategic Grid/Boston Matrix) ❖ Classifies client-provider relationships into Reliance, Alliance, Support and Alignment types
Holistic Approach Framework *(Ho, 2004)*	❖ Involves business (user), information (technical) and organizational perspectives ❖ Addresses issues within multiple domains, such as economical, political and technological ❖ Designed to incorporate financial costing and take into account legislative influences

Analysis of the identified frameworks indicates that majority are based on the use of the Strategic Grid/Boston Matrix (SG/BM) positioning grid, which is a well-established technique (Earl, 1989; Ward & Peppard, 2002). There is clear consensus in literature of its use in generic business decision-making (Laudon & Laudon, 2000; Pearlson, 2001; Ward & Peppard, 2002) as SG/BM-based frameworks are intuitive to use for business users.

A review of the outsourcing literature emphasizes the need for strategic frameworks to incorporate quantitative measures to help practitioners set priorities and provide the most benefits from outsourcing (Yang & Huang, 2000). The failure to address this aspect is one of the main inadequacies of the majority of the frameworks reviewed, only three of which incorporate quantitative measures.

The analysis highlights a lack of financial costing and benchmarking in most of the reviewed frameworks, which is contradictory, as cost savings and service level improvements are commonly identified as the top drivers behind the use of outsourcing. Financial costing is considered to be particularly important within a framework approach, as it facilitates the ability of the business to benchmark its cost position relative to external service providers and provides a comprehensive financial justification in the decision-making process.

Management of Outsourcing

Like all management operations, a consensus of advantages and associated risks of using third-party contractors (i.e., outsourcing service providers) has to be considered and evaluated. A summary of the factors in terms of outsourcing have been compiled and detailed in the following sections.

Factors for Successes and Failures

Although the business context in which outsourcing is utilized may vary widely, resulting in a vast combination of variables that influence outcomes, it has been noted that there are some common characteristics and traits in outsourcing moves that indicate its inclination towards success or failure. These commonalities, termed key factors, are briefly outlined as follows:

Factors for Successful Outsourcing

- **Understanding of company goals and objectives:** that is, there is a clear understanding of what the company hopes to achieve via the use of outsourcing; for example, access to advanced technology and specialist skills.
- **Strategic vision and plan:** that is, a defined roadmap details how outsourcing will aid the company in progressing towards its strategic objectives and long-term goals.

- **Executive and management level buy-in:** that is, there is senior executive support and involvement through the outsourcing lifecycle, from the decision process to the implementation process.
- **Comprehensive financial justification in decision process:** that is, the outsourcing decision is justified by a detailed financial analysis, which benchmarks the company's internal cost position against that of external service providers.
- **Use of external expertise in decision process:** that is, lawyers, independent consultants and financial advisors are utilized to provide expert insight and advice on the legal, financial, economic, technological, political and organizational aspects.
- **Open communication with affected individuals and groups:** that is, employees and trade unions are informed and consulted about the potential outsourcing and its corresponding implications.
- **Careful selection of right service provider:** that is, there is an objective decision process in which the service provider with the best technical capabilities, financial feasibility and cultural fit is selected.
- **Ongoing management of outsourcing relationship:** that is, there is constant monitoring and management of various aspects of the outsourcing lifecycle, from the selection process to the implementation process.
- **Quantifiable performance monitoring:** that is, the company has established an objective and measurable method of ascertaining the compliance of performance standards in the service provision.

Factors for Unsuccessful Outsourcing

- **Short-term benefits dominate as the motivation:** that is, the outsourcing deal is handled as a purchasing decision rather than a strategic investment opportunity.
- **Service providers are not "pre-qualified" on their total capabilities:** that is, service providers are not short-listed by a comprehensive evaluation prior to selection.
- **Service provider literature dominates the decision process:** that is, case studies provided by the service provider, which are biased towards reporting only positive results, are used as the basis for deciding to outsource.
- **Management team lacks decisional authority and experience:** that is, the lack of experienced staff who have the incentives (personal, professional and economic) and authority to ensure the outsourcing deal succeeds.
- **Lack of defined processes for incident resolution and change management:** that is, the lack of defined processes for escalating problems, negotiating change requests and periodically reviewing the service provision contract.

Selecting and Managing Service Providers

Prior to the selection of service providers, companies need to have identified two important aspects of information; namely, well-defined service expectations and an understanding of their internal cost metrics. Service expectations serve as a guide by which contractual needs can be assembled and then negotiated with potential service providers, while the internal cost metrics can be used to establish a "base case" for use in financial analysis. By using the "base case" as an estimate for current costs, a comprehensive financial analysis can then be conducted to benchmark the company's cost position relative to that of external service providers. This would, in turn, provide for the financial justification on whether to retain the evaluated services in-house or to outsource them.

Companies then need to articulate a clear mission statement for the type of outsourcing relationship to be established between themselves and their potential service providers. There needs to be well-defined objectives and performance metrics by which the services to be provided can be measured on a continuous basis, and companies should ensure that short-listed service providers already have an effective tracking and reporting system in place for that purpose. It is beneficial for companies to have direct access to the service providers' tracking and reporting software for data capture about the performance of technology within the company, thus allowing technology use to be evaluated and areas for exploitation to be identified. Overall, an outsourcing relationship with the ideal service provider will involve committed and supportive management, which includes continuous service management and performance monitoring on an ongoing basis.

In the selection of such service providers, companies have indicated the following to be the most important factors (Sparrow, 2005; 2004 Global IT Outsourcing Study, 2004):

- **Reputation and proven track record:** that is, the service provider has achieved results for similar companies that are willing to serve as references.
- **Cultural fit:** that is, senior executives and company staff are likely to be able to work well with that of the potential service provider, and are agreeable with its practices and processes.
- **Financial stability:** that is, the service provider is profitable, with good long-term growth potential and development prospects.
- **Functional area expertise:** that is, the depth and breadth of the service provider's expertise adequately cater for the needs of the outsourced services.
- **Vertical industry expertise:** that is, the service provider has an understanding of the client company's industry and, hence, is able to customize an outsourcing solution specific to the client's organizational needs.

In addition to the above, other factors that should be considered include the flexibility of the contract terms, the scope of resources (both personnel and equipment) required for implementation and the service provider's ability to value-add to the client's internal capabilities.

There needs to be due diligence in documentation procedures; that is, documents should be reviewed periodically and kept up-to-date. Present and proposed hardware/software configurations should be documented, along with the methods utilized to evaluate submitted bids. A summary checklist, which includes service provider name, contact person and bid submission date, should be also compiled for quick reference. In addition to facilitating objective decision-making based on accurate information, the documentation process can aid in the establishment of a formal method for the selection of service providers in future outsourcing processes.

Service Level Agreements (SLAs) are considered to be integral to the outsourcing process, particularly with regards to service management. SLAs are negotiated agreements of common understanding between clients and service providers that define the services provided along with their expected levels of performance, and corresponding penalties and consequences for non-compliance. They explicitly define the relationship between customers and service providers (Leff, Rayfield, & Dias, 2003) and can be used in the context of any industry (Verma, 2004). For effective and efficient implementation in an outsourcing relationship, companies will need to ensure that the SLAs encompass a good degree of legal adherence, quantitative metrics for performance monitoring and an established exit clause in the event that contract termination is deemed necessary.

Stages in Outsourcing Implementation

Companies should utilize a systematic approach to outsourcing implementation in order to facilitate an objective perspective in the decision process. Figure 4 illustrates such an approach, involving six suggested stages, outlined as follows:

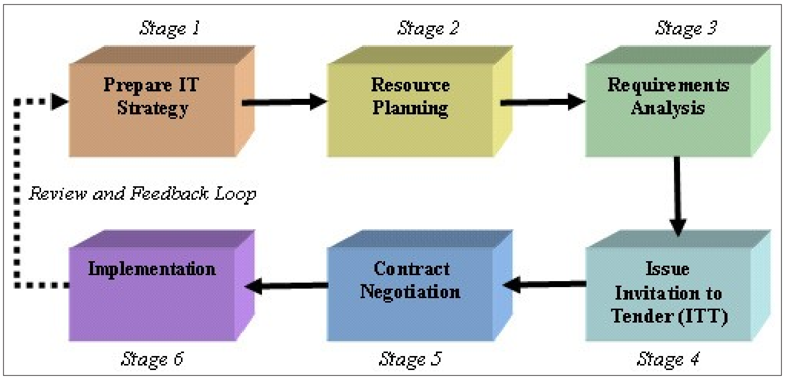
Stage 1: Prepare IT Strategy

In the initial stage, companies should clearly articulate defined business objectives and develop an IT strategy that will enable them to progress and align with the business goals. Framework techniques, such as the generic framework or one of the other strategic frameworks earlier outlined, can be utilized to determine what aspects of the existing IT functions (e.g., partial or total) are outsourcing candidates. A thorough evaluation is needed to identify the mission-critical applications for strategic retention, and the level of internal expertise required to prevent loss of organizational competencies, and hence safeguard against lock-in risks. A rigorous review of legislative implications is also needed to determine the legal feasibility of outsourcing.

Stage 2: Resource Planning

The next stage in the process is resource planning, in which the resources (both personnel and equipment) currently required for maintaining the functions in-house are

Figure 4. Stages in outsourcing project



identified. The identification facilitates the creation of a resource utilization table (e.g., breakdown into volume of data transmission, processor capacity required, etc.) in which the resource commitment for the various functions can be detailed, thus allowing resource-intensive functions to be flagged. Subsequently, these resource-intensive functions can then be evaluated for suitability for streamlining (e.g., Business Process Re-engineering) or elimination (e.g., outsourcing to external service providers). An understanding of the internal cost metrics is required, in order to establish a "base case," commonly formulated via the Activity-Based Costing (ABC) method, by which submitted tenders can be evaluated against later (Massy, 1999). It is important to ensure that human resource issues are not overlooked at this stage, as outsourcing has a definite impact on staff morale; hence, companies may have to commit more resources (possibly financial) to make corresponding adjustments to restore internal work efficiency. In some instances, it may be appropriate to utilize consultants to help identify the company's strategic intention at this stage.

Stage 3: Requirements Analysis

Requirements definition is a vital part of the outsourcing implementation process, as inaccurate definition of requirements can result in implementation delays, resource waste and client dissatisfaction. The requirements analysis should begin with business requirements and translate those into performance requirements of the functions to be outsourced. The requirements analysis method will be specific to the context of individual companies; some may prefer the use of formal project methods, while others may prefer the use of informal brainstorming sessions as the basis. Typically, companies have found it helpful to utilize Service Level Specifications to set measurable requirements and performance criteria. Sometimes companies may inevitably omit the required clarity and details, which results in an ambiguous definition; hence, it is recommended that the completed requirements analysis be reviewed by a select management committee before progressing further.

Stage 4: Issue Invitation to Tender (ITT)/Request for Proposal (RFP)

The ITT stage, also known as RFP stage, is a procurement procedure where clients invite service providers to tender for the functions to be outsourced. The key component of this stage is the ITT/RFP document, which should comprise the following sections:

- **Introduction:** for example, industrial context, goals and objectives of the outsourcing move, and the procurement timetable.
- **Background:** for example, background information about the company, details of the technical environment and the current business systems in place.
- **Scope and scale of functions:** for example, detail and scope of the functions to be outsourced, such as number of users, number of transactions and data transmission volume.
- **Key requirements:** for example, the most important requirements, such as legal adherence to data protection legislations.
- **General requirements:** for example, a description of service provision and type of outsourcing relationship to be established, such as strategic partnership.
- **Detailed functional requirements:** for example, a full description of what is specifically required from the service provider.
- **Technical requirements:** for example, details on technological direction, software and hardware.
- **Cost information required:** for example, details of costs for various activities, such as licensing, training, consultancy, development, customization and implementation.
- **Service provider information required:** for example, contact details, parent company name, financial backing details, company audits and evidence of ability to deliver.
- **Implementation requirements:** for example, timescales, preferred project methodology and resource utilization.
- **Instructions to service provider:** for example, format and content of tender responses, selection criteria and submission deadlines.
- **Appendices:** for example, organizational charts, glossary of terms and business process diagrams.

It is important to state that service providers must maintain the strict numbering used in the ITT/RFP document, which makes it easier to check whether the service provider has replied to each defined requirement. Companies often also opt to include a compliance grid that service providers have to complete and which facilitates a quick review of requirements fulfilled. It is also important to emphasize the clear cut-off date for tender submission and clarify that tenders delivered after that date will be rejected outright.

Stage 5: Contract Negotiation

The contract negotiation stage involves negotiating with the selected service provider to reach a suitable contractual agreement. There is a natural tendency for companies to desire a speedy negotiation after a potentially time-consuming selection process, but it should be noted that a haphazard contract may lead to later complications, which can be costly in terms of both time and finance. In this stage, the service provision issues that should be discussed are performance standards, compliance monitoring, change management procedures, technological review periods and penalties for non-compliance. Typically, these issues are addressed by the establishment of Service Level Agreements. Companies should include acceptance testing into the contract as a means of ascertaining whether the client requirements have been adequately met. Ideally, various safeguards should be worked into the contract, such as the following:

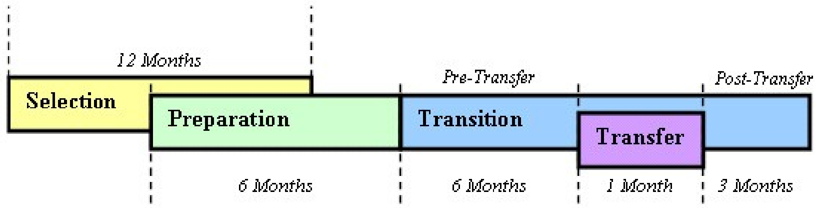
- Non-disclosure clause for information identified as confidential or company secret.
- Unambiguous definition of Intellectual Property (IP) rights.
- Requirement for implementing a recognized code of practice on information security.
- Ability to veto the use of sub-contractors (i.e., further outsourcing of functions).
- Exit clause in the event contract termination is deemed necessary.
- Procedures to account for business changes where both parties share any potential savings from new technology or process streamlining (i.e., mutual goal sharing).

There should be a clear escalation hierarchy and dispute resolution procedures in terms of problem resolution. In instances where traditional pricing arrangements are deemed inadequate, companies can opt to utilize escrow arrangements, where a third-party intermediary acts as a security buffer between the client and service provider. During this stage, contract negotiation should be built on trust and not developed in an adversarial way. Overall, companies should have a good understanding of the market, and thus have a grasp of their bargaining power in the contract negotiation with service providers.

Stage 6: Implementation

The implementation stage involves the establishment of monitoring procedures and ascertaining the compliance of performance standards in the service provision. For the client-provider relationship to be truly effective, constant communication is a vital key, and thus it is important that communication channels and feedback procedures are established to facilitate constant and open communication. It is also important that formal procedures are developed to resolve issues in a convivial rather than an adversarial way. As outsourcing is a potentially long-term commitment, companies need to build up a working strategic client-provider relationship based on trust, and work towards designing contracts that account for the speed of business changes.

Figure 5. Time estimates for outsourcing implementation



It is recommended that companies establish a feedback loop by means of review sessions, typically carried out 4 to 6 weeks after implementation, to identify any best practices and isolate problem areas. This is important, as it provides review information that can be utilized in future implementations to preempt potential problems and can facilitate knowledge transfer, through documented practices, from experienced staff to those in training.

Companies should note that the implementation of outsourcing requires considerable time commitment, as illustrated in Figure 5, and hence should be integrated into the organizational strategy. Noticeably, as companies extend the practice of best/smart-sourcing, they accrue knowledge from experience, and the resultant conversance with the process aids in reducing the time cycles of outsourcing implementation.

Emergent Trends

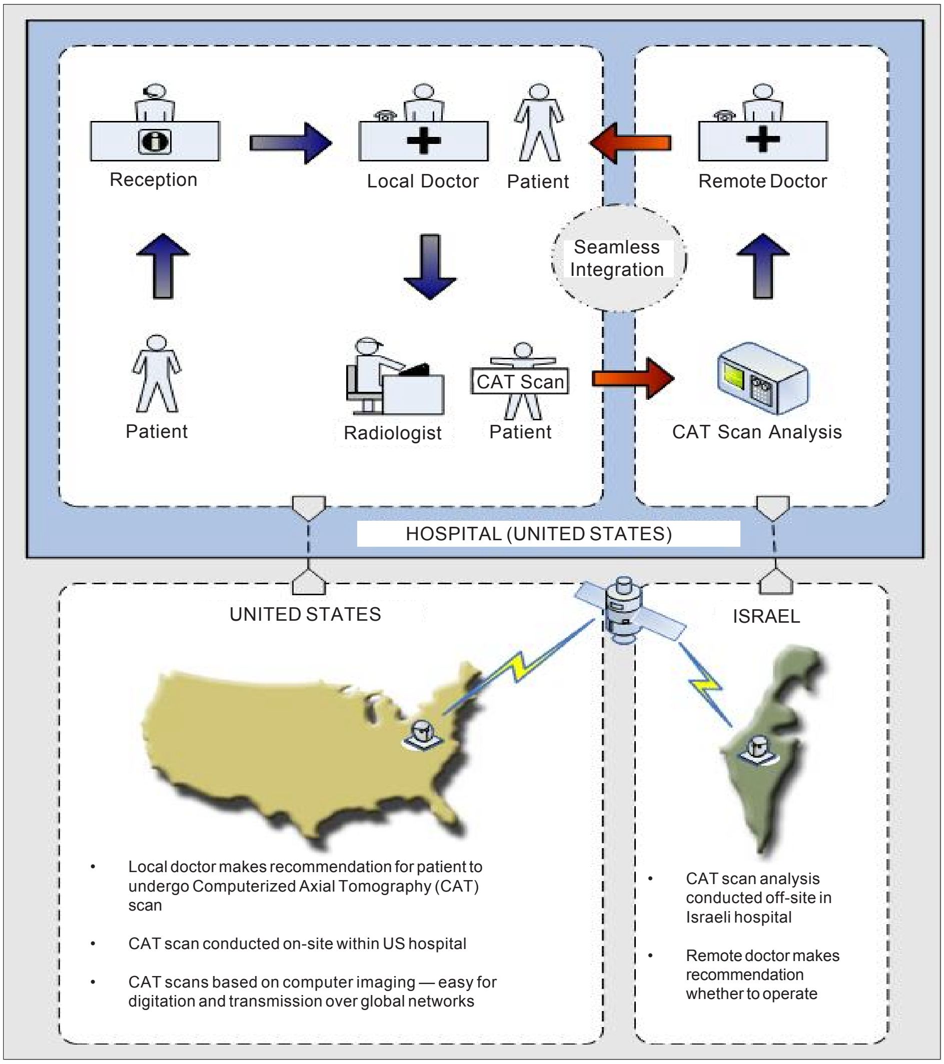
To maintain competitive advantage from outsourcing, companies need to identify emergent trends and understand their corresponding implications, a selection of which is outlined as follows:

Sourcing Strategies

Some companies are acquiring services from best-of-breed service providers located anywhere in the world, thus potentially involving a combination of on-shore, near-shore and off-shore work. This outsourcing strategy, which is sometimes known as "Best-sourcing" or "Right-shoring," has been spurred on by the recent globalization effects produced by three forces (Friedman, 2004).

First, increased bandwidth, reduced telecommunication costs due to deregulation and dramatic improvements in undersea fiber-optic technology (Namasivayam, 2004) have made it economically possible to globally transmit and store huge amounts of data. Second, the diffusion of computers around the world has proliferated access to comput-

Figure 6. Seamless integration of outsourced CAT scan analysis



ing capabilities; and finally, the increased availability of groupware and collaboration tools have empowered virtual teamwork. The combination of these forces has facilitated the creation of workflow platforms, which can divide almost any service job (e.g., radiology scan analysis and accounting) into various functions. Exploiting this with digitization technology (e.g., conversion of data by high-resolution scanning system) has allowed each function to be outsourced to best-skilled knowledge workers around the world, beyond geographical and physical boundaries.

Figure 6 illustrates this concept with the outsourcing of Computerized Axial Tomography (CAT) scan analysis. While the CAT scans are taken on-site within a hospital in the U.S., the analysis and subsequent recommendation on whether to operate can be made by a remote doctor overseas, such as in Israel. Information can be reviewed quickly because of the difference in time zones, thus allowing the CAT scans to be analyzed overnight (working day in Israel). This setup also provides coverage for the US hospital to deal with emergency cases arriving at night that require urgent attention. Due to the seamless integration of information interchange, boundaries between the US-based components and Israeli-based components are indistinct, and hence, patients are often unaware that the hospital is essentially a virtual organization.

Global sourcing strategies have been recently expanded to include an obscure form of outsourcing, known as Rural-Sourcing, in which the provision and management of services are transferred to rural regions of the client organization's home country (e.g., Arkansas in the U.S.). It has been indicated that Rural-Sourcing has the potential to deliver up to 40% cost savings, which is close to being on par with an offshore offering (Frauenheim, 2004). Furthermore, the concept of retaining jobs onshore and benefiting rural communities in the process presents an opportunity for companies to project a positive public image. As such, Rural-Sourcing is expected to be an increasingly viable alternative to Offshore Outsourcing, which has generated considerable negative publicity due to the controversial connotation of job losses to the client country and the potential of long-term adverse effects to its economy.

Regulatory Requirements Related to Outsourcing

There has been an increase in the number of regulatory requirements that must be satisfied to implement an outsourcing deal. Care will need to be taken to ensure that the unique constraints enforced by national legislations are understood and followed for success in global outsourcing operations. The key national legislations that must be taken into account are outlined as follows:

- The U.S. **Sarbanes-Oxley Act** (2002) introduced following various corporate financial scandals, such as Enron and WorldCom, requires CEO/CFO certification of financial statements, potentially including those of outsourced activities (penalties of $1 million in fines and up to 10 years of jail time if wrong certification was knowingly submitted).
- The U.K. **Transfer of Undertakings (Protection of Employment) Regulations** (1981), recently expanded to include outsourcing, advocates that employees involved in a transfer will automatically continue in their jobs with their existing terms and conditions (for 2 years), and requires that recognized trade unions and elected employee representatives be informed and consulted about the potential transfer along with its corresponding implications.
- The U.K. **Data Protection Act** (1998) imposes a duty for "data controllers" to comply with a set of eight data protection principles, and the eighth principle has particular implications to Offshore Outsourcing to regions outside of the European Economic Area (EEA).

- The **Basel II Capital Accord** (2004) is a complex new standard for measuring credit risks, market risks and operational risks in financial services organizations, which has implications towards risk management strategies with regard to outsourcing operations.
- The UK **Financial Services Authority Handbook** (2005) has developed an outsourcing policy as a statement of good practice for operational risk management, which advocates that a company's management is accountable for the adequacy of systems and controls for the outsourced activities, and requires advance notification to the Financial Services Authority in the event that an outsourcing decision has been made.

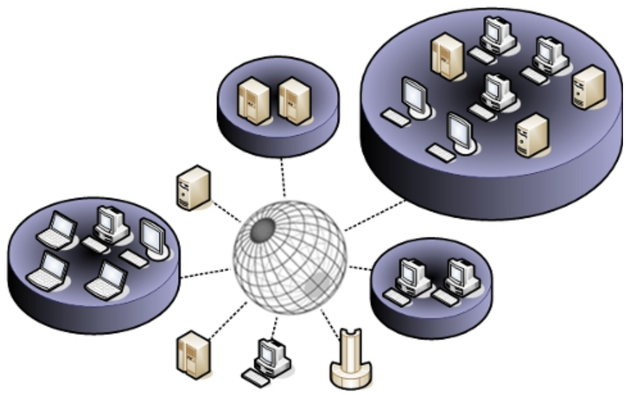
These legal developments present implications and opportunities for both clients and service providers of outsourcing. In the short term, such legislations complicate the outsourcing scenario and require clients to assess the service providers' capabilities to meet the requirements imposed on the operational components they are managing or will manage. On the part of service providers, the legislations will prove to be a challenge as they progress towards understanding and addressing of such requirements, and to prove to potential clients that they have the capabilities to do so. In the long term, it will drive outsourcing opportunities, as service providers gain opportunities and competitive differentiation by cost-effectively and efficiently supporting client needs to meet the complex requirements imposed by the legislations. The legislations are inclined towards requirements of a financial nature; hence, it is expected that service providers with stronger business process and financial services knowledge will fare better against more IT-centric or technically-focused service providers, particularly those located offshore. It is also anticipated that risk assessment, particularly financial-related, will increasingly be of concern to companies in the evaluation of potential outsourcing operations.

Business Application Grids

The term "the Grid" was coined in the 1990s to denote a proposed distributed computing infrastructure for advanced science and technology (Foster & Kesselman, 1998). Since then, considerable progress has been made on the construction of such an infrastructure (Foster, 2001); hence grid-based computing is emerging as a viable technology.

Grid-based computing can be defined as a network of computation, involving tools and protocols for coordinated resource sharing (e.g., processor execution time and system memory) and problem solving among pooled assets, which are known as virtual organizations (Myer, 2003). It is a form of distributed computing in which a wide-ranging network connects multiple heterogeneous computers into a pool of potential labor, as illustrated in Figure 7, allowing resources to be shared by all end-users. One application of grid-based computing to business enterprises is the Business Application Grid (BAG). As computing capabilities within companies are typically under-utilized, with desktop machines using 5%-10% of their capability and most servers peaking out at 20% usage (Myer, 2003), the BAG is particularly attractive to companies seeking to harness the full

Figure 7. Conceptual diagram of a Business Application Grid (BAG)



processing capabilities of their computing facilities. This was highlighted by the Charles Schwab insourcing deal managed by IBM, involving the application of a BAG on financial services, which has reduced the internal processing time on an existing wealth management application from more than 4 minutes to 15 seconds (Shread, 2003).

The advent of grid-based computing and other distributed on-demand computing technologies present a new service model for outsourcing service providers, known as Services Computing, which will enable companies to purchase processing capabilities as required (Zhang, Li, & Lam, 2004) in a manner akin to IBM's concept of "On-Demand Business." This allows leverage of grid-based computing technologies to take advantage of under-utilized computing capability for business applications, thus enabling companies to work towards gaining strategic competitive advantage on an enterprise-wide basis.

Conclusion

Outsourcing is now a mainstream strategy in a myriad of industries, and the magnitude of its impact and its potential as an enabling tool is something that few companies can ill afford to ignore. The creation of workflow platforms coupled with digitization technology (e.g., conversion of data by high-resolution scanning system) has allowed business functions to be outsourced around the world, giving round-the-clock coverage. However, even as Offshore Outsourcing becomes an increasingly mature and commonplace process, companies need to carefully evaluate the advantages and risks involved in each location choice and ideally adopt the strategy of "Right-Shoring." With the advent of increasingly changing market dynamics and the complex nature of outsourcing-related legislations, it is vital that companies handle outsourcing as a strategic investment opportunity rather than a simple purchasing decision. Companies should continuously evaluate existing outsourcing arrangements, and country of operations, to ensure competitive pricing from service providers and prevent over-dependency. To best exploit the recent developments in outsourcing to maintain the strategic edge, companies should consider the following points:

For Clients (and Potential Clients) of Outsourcing

- Utilize strategic frameworks in the decision process for analysis to identify potential candidates for outsourcing and corresponding concerns.
- Conduct a comprehensive financial analysis, via costing methods such as ABC, to benchmark the internal cost position against that of external service providers to determine fiscal feasibility of outsourcing.
- Maintain awareness of new outsourcing-related legislations and their corresponding impact to determine the need for outsourcing to ensure compliance.
- Explore the use of BAGs as a means to harness under-utilized computing capability within the organization.
- Consider the financial viability of Rural-Sourcing for potential to project a positive image by retaining jobs onshore and benefiting rural communities in the process.
- Exploit the concept of virtual organizations; for example, in applications such as remote medical diagnosis of CAT scans and providing inter-hospital consultative support using digital images in complex medical procedures.
- Avoid the use of outsourcing as a means to "dump" problematic internal functions—outsourcing is not a panacea.

For Service Providers of Outsourcing

- Cultivate a proactive, effective and efficient approach to service management, focused on user satisfaction, which encourages current clients to act as references.
- Provide proof of ability to address new legislations to capture a share of the expanding market of outsourcing for legal compliance.
- Maintain awareness of emergent service provision models (e.g., Services Computing) to synchronize the portfolio of services offered with market demand.
- Consider the viability of partnerships and joint ventures to establish a multinational presence to target the potential market from increased adoption of "Right-Shoring."
- Develop innovative outsourcing solutions that focus on gaining strategic advantage on an enterprise-wide basis to attract companies moving beyond the traditional objectives of operational cost reduction and service level improvements.

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Chapter XIII

IT-Enabled Integration of Business Relationships in the Steel Industry Context

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Abstract

Companies engage in many business relationships; however, the number is decreasing constantly, so existing relationships are increasingly valuable. The purpose of this chapter is to highlight how inter-organizational relationships can be seen as a source of competitive advantage and how, in order to survive in a hyper-competitive landscape, key relationships are integrated with new information technology solutions, such as ERP. This chapter focuses on the changes brought about by technology integration in the context of the steel industry with the help of a longitudinal case study. The chapter sheds some light on factors affecting the changes occurring in business relationships and illustrates how those alterations can be managed. It seems that information technology integration within a business relationship is a complex process that depends on characteristics of the adopted technology as well as the relationship. Subsequently, implications are discussed together with suggestions for future research. Lastly, the limitations are briefly stated.

Introduction

Information technology (IT) has changed the way a business operates (Dertouzos, 1997; Kaufman, 1966); new business models are being created both in the business-to-business (Raisch, 2001; Timmers, 1999) and consumer markets (Timmers, 1998). In addition, electronic marketplaces are seen as a source of competitive advantage by many respectable companies, such as IBM and Cisco Systems, who participate as buyers in many electronic marketplaces and provide the technology for these and other marketplaces. Moreover, companies like GE and DaimlerChrysler have their own marketplaces to drive down procurement and other costs, but the business logic of these marketplaces still runs counter to the best recent thinking on business relationships (Wise & Morrison, 2000). Because the number of electronic marketplaces has shrunk both globally (Jap & Mohr, 2002) and in the steel industry (Candell, 2000), instead of electronic exchanges we study business relationships as a source of new value creation in the context of the steel industry.

Moreover, different networking technologies, from the Internet to the extranet, have caused managers to rethink individual businesses (e.g., book shops), but these technologies have also impacted tremendously on whole industries (e.g., the insurance and banking industries). Thus, IT-enabled integration of business relationships is a vital area for research. Furthermore, there is a gap in the area of strategic business relationship management from the IT perspective (see Leek, Naudé, & Turnbull, 2003). First, we briefly define the concepts used in this chapter:

Information technology is a term that encompasses all forms of technology utilized to create, capture, manipulate, communicate, exchange, present and use information in its various forms (business data, voice conversations, still images, motion pictures, including those not yet conceived). (Ryssel, Ritter, & Gemünden, 2004, p. 198)

To continue with strategy, Walker, Boyd, and Larreche (1992) suggest that *a good strategy* from a business perspective should have the objective of gaining a competitive advantage. Thus, from the business relationship perspective, a good strategy is one that aligns business relationship types and relationship management to form the optimal relationship portfolio (see Johnson & Selnes, 2004; Krapfel, Salmond, & Spekman, 1991). Since there are many types of business relationships, from those at arm's length to those that are almost hierarchical (Webster, 1992), different relationships require different managerial actions; therefore, optimal performance is hard to achieve.

A research void, which is both managerially and academically interesting, has been identified in the intersection between the business relationship discussion and the IT discussion. To elaborate, there is a growing interest in IT-enabled integration of business relationships, and the expanding body of literature is highly inconsistent and fragmented (see Holland & Naudé, 2004; Johnston & Mak, 2000). Furthermore, it is noted here that IT and electronic commerce literature to date have addressed market and hierarchy governance mechanisms (e.g., Alba, Lynch, Weitz, Janiszewsi, Lutz, Sawyer, & Wood, 1997; Grewal, Comer, & Mehta, 2001; Malone, Yates, & Benjamin, 1987, 1989) rather than business relationships (Salo, Karjaluoto, & Leppäniemi, 2004). Therefore, this chapter attempts to provide a framework that sheds some light on the changes brought about by IT-enabled integration of business relationships. Moreover, we attempt to illustrate the factors underlying these changes that impinge on business relationships and how these changes in business relationship logic should be managed.

This chapter unfolds as follows: We begin with a discussion of business relationships and competitive advantage; we then touch upon the IT integration discussion. Next, we highlight the changes and challenges that IT brings into a business relationship. After that, we briefly introduce the longitudinal case study method. We end the chapter by summarizing the results and presenting specific future research areas.

Structure and Processes Aspects of Business Relationships

Aside from the fact that the number of business relationships that exist between buyers and sellers has decreased, importance of trade contracted within a business relationship has simultaneously increased (e.g., Bakos & Brynjolfsson, 1993; Matthyssens & Van den Bulte, 1994). The fact remains that in many cases it is not profitable to play dozens or even hundreds of competing suppliers against each other; working closely with a few suppliers within a business relationship is generally profitable for both parties. This is due to the fact that as the number of possible partners increase so too do transaction costs (see Clemons, Reddi, & Snow, 1993; Kumar & Dissel, 1996; Stump & Sriram, 1997). Therefore, it is evident that existing business relationships are a vital area for research.

Business relationships can be approached from a plethora of theoretical paradigms. These include: the political economy approach (Benson, 1975; Stern & Reve, 1980), the transaction cost approach (Coase, 1937; Rokkan, Heide, & Whatne, 2003; Williamson, 1975) and the relationship marketing thinking (Berry, 1995; Grönroos, 1994; Gummesson, 1987; Palmer 1994), as well as the Industrial Marketing and Purchasing (IMP) perspective (Håkansson, 1982; Turnbull, Ford, & Cunningham, 1996). Additionally, IT and information system scientists have approached inter-organizational relationships (IOS) from their point of view. For integrative discussion on the IOS perspective see Chatterjee and Ravichandran (2004). All of these theories have been employed to highlight business relationship issues. In addition, the above-mentioned research streams are theoretical, and with their managerial recommendations they offer heterogeneous perspectives for studying IT-enabled integration of business relationships. Here, we focus on the business relationships with the help of the IMP perspective (Ford, Gadde, Håkansson, & Snehota, 2003; Håkansson, 1982; Turnbull, Ford, & Cunningham, 1996). This means that we focus on both personal and impersonal (IT-enabled) relationships between the people that constitute the business relationship to be studied (Cunningham & Turnbull, 1982; Turnbull, 1979). The functions of business relationships can be roughly divided into structural and process-oriented elements (Håkansson & Snehota, 1995). Structural characteristics are continuity, complexity, symmetry and informality, while process characteristics are adaptation, cooperation and conflict, social interaction and routinization.

For structural characteristics, it has been reported that the major supplier and customer relationships of a company show a striking *continuity* and have relative stability. The length of the business relationship has been reported to be from 6 to 20 years. Business transactions conducted repeatedly build up the relationship and often have distinct phases of contracting, delivery, post-delivery, assistance and service. Various reasons have been discovered as to why business relationships are so complex. One of these elements of *complexity* is the number, type and contact pattern of individuals involved in the relationship. Hallén (1986) describes that international business relationships have 5 to 10 or more people on each side of the business relationship actively interacting. Additionally, individuals have very different organizational roles, statuses and personal backgrounds. Håkansson and Snehota (1995) notice that business markets are more *balanced* than consumer markets, due to the fact that in a business relationship both business parties have resources and capabilities that are more equal. Resources could be, for example, knowledge, labor force, financial, technological or other resources controlled to take initiative and promote changes. Additionally, they illustrated that business relationships show *a low degree of formalization,* meaning that while formal contracts are common, they often play a limited role. This is due to the fact that formal contracts are seen as ineffective in taking care of uncertainties, crises and conflicts. The reliance on informal bonding is seen as a common form of trust in many business cultures.

Process characteristics are labeled as the nature of the interaction processes. It has been recognized that mutual *adaptations* are a prerequisite for the development and continued existence of a relationship between two companies (Hallén Johanson & Seyed-Mohamed, 1991). Adaptations stem from the need to coordinate the activities of the individuals and companies involved in the business relationship. Technical adaptations in production or process technologies are common, but so are adaptations in administrative and logistic activities. These adaptations, including both direct and indirect, contribute to mutual commitments that both constrain and empower companies. In business relationships, elements of *cooperation and conflict* co-exist in the atmosphere of the relationship. Benefits must be divided between the business parties; due to this, conflict is inherent. However, cooperative posture is necessary to avoid the danger that the relationship becomes a zero-sum game. It is expected that a business relationship is mainly about business and business-specific behavior. Nonetheless, subjective values, personal bonds and convictions are present at all times and play an important role in the formation of the relationship. It has been noticed that a business relationship is built up as a *social exchange* process in which the individuals who take part become committed beyond just task content. The web of personal relationships is a prerequisite for the development of inter-organizational ties. The trust built from these social interactions emerges, as one of the salient factors influencing interaction in inter-company relationships. Håkansson and Snehota (1995) illustrate that while business relationships are often complex and informal in nature, they tend to become routine over time. In brief, routines are explicit and implied rules of behavior and rituals of conduct that emerge over time. These routines make the business relationship work more efficiently.

It is acknowledged here that IMP literature has been criticized for being too focused on social exchange as the main element in the business relationship. As such, it is rightfully asked how IT integration occurring in a business relationship has impacted on these and if the IMP theories should be modified to reflect the changes occurring in business markets.

Now, we briefly elaborate how to select the right business relationship to be integrated with IT. The literature provides countless examples of evaluating a business relationship's importance and value from either a seller's or buyer's perspective (Bensaou, 1999; Fiocca, 1982; Kraljic, 1983; Johnson & Selnes, 2004). Usually, the elements dealt with in these matrix presentations are customer or seller benefits and costs. Benefits are usually related to money, knowledge, skills, learning possibilities and reference, while costs are related to product characteristics, service elements, complexity of needs and volume of purchases. Thereby, it can be concluded that all business relationships are unique, but some can be classified into groups to some extent. What make it difficult are expectations about the future of relationships, including total relationship specifics, which is complex to estimate. Thus, the optimal relationship portfolio and performance is not easy to come up with. In here, we implicitly assume that managers of those important relationships can estimate the importance of the relationship and the value that can be gained while digitizing the business relationship with the help of the new IT solutions. After we have described the underlying features of business relationships, we can describe characteristics and purposes of IT integration in order to later show how business relationships are impacted by IT integration.

IT-Enabled Integration

Previous sections of this chapter have revealed that IT may enable integration between companies (see Mukhopadhyay & Kekre 2002; Yang & Papazoglou, 2000). This blurring of organizational boundaries in IT is not a new phenomenon, as Kaufman (1966) noted. However, a great deal has changed both in IT and business logic since Kaufman's (1966) seminal article. The importance of outsourcing and different types of alliances and business relationships have forced companies to be able to connect and ultimately to integrate with different types of systems that their customers and their suppliers possess. Thereby, besides IT management skills (Mata, Fuerst, & Barney, 1995), more specific integration capabilities and skills are needed. Data sharing and transparency of value chains has become also an important research topic (Eggert & Helm, 2003; Konsynski & McFarlan 1990; Stefansson, 2002). Within business relationships, it is difficult to estimate the amount of information that needs to be shared; as Liker and Choi (2004, p.112) illustrate, "… sharing a lot of information with everyone ensures that no one will have the right information when it's needed." Since we have now purported that the topic is vital and needs more research, we must define our main concept: IT-enabled integration.

In short, IT-enabled integration refers to partial or total integration of information systems inside sub-units of an organization (Figure 1), between organizations' sub-units (Figure 2), between companies that have integrated internal systems (Figure 3) and between business relationships that form a business network with the help of IT (e.g., Hasselbring, 2000). Partial integration refers to the use of messaging services or similar arrangements, while total integration refers to deeper integration that enables truly real-time and dynamic information exchange. Figure 1 illustrates the simplest and most common integration usually achieved through centralized decision making related to IT.

Figure 1 shows the situation in which both companies C and D have isolated IT infrastructures between their sub-units A, B, E, F and G. This kind of state was a rule rather than an exception in the 1980s and even until the late 1990s. At that time, large mainframe systems (and before that, punch card systems) were isolated systems with usually one or a few purposes. *Business architecture,* according to Hasselbring (2000), encompasses "… the organizational structure and workflows for business rules and processes." At that point in time, the business architecture did not cross over sub-units' boundaries, and therefore, integration of business processes were not needed until recently. *Application architecture,* according to Hasselbring (2000), includes the elements needed in … the actual implementation of the business concepts in terms of enterprise applications. In short, this is the so-called glue between the business and technology architecture. *Technology architecture,* according to Hasselbring (2000), comprises information and technology infrastructure. Figure 1 depicts a situation in which business-specific software—that is, applications—were run on mainframes within each sub-unit. However, today, companies have moved away from the above-mentioned spurious thinking that drives organizational structure and information systems into silos presented above towards more horizontally integrated systems. Figure 2 depicts horizontal integration within companies C and D.

Figure 2 shows how sub-units of companies C and D are integrated to form a coherent information infrastructure for the company in question. This is done with the help of different types of integration software. At the business architecture level, the sub-units are integrated by stating the organizational objectives clearly and by creating intra-company processes that cut organizational boundaries. Usually these processes are customer focused and add value at each step. The value might be increased by adding

Figure 1. Tight sub-unit structure without intra- or inter-organizational IT integration (Modified from Hasselbring, 2000)

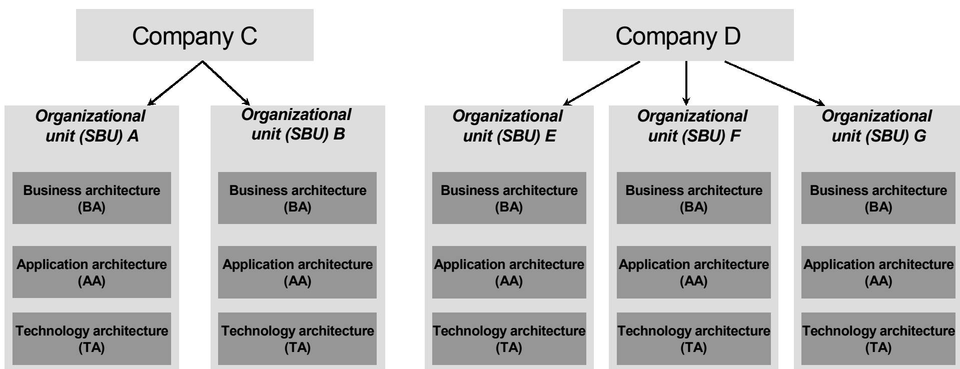
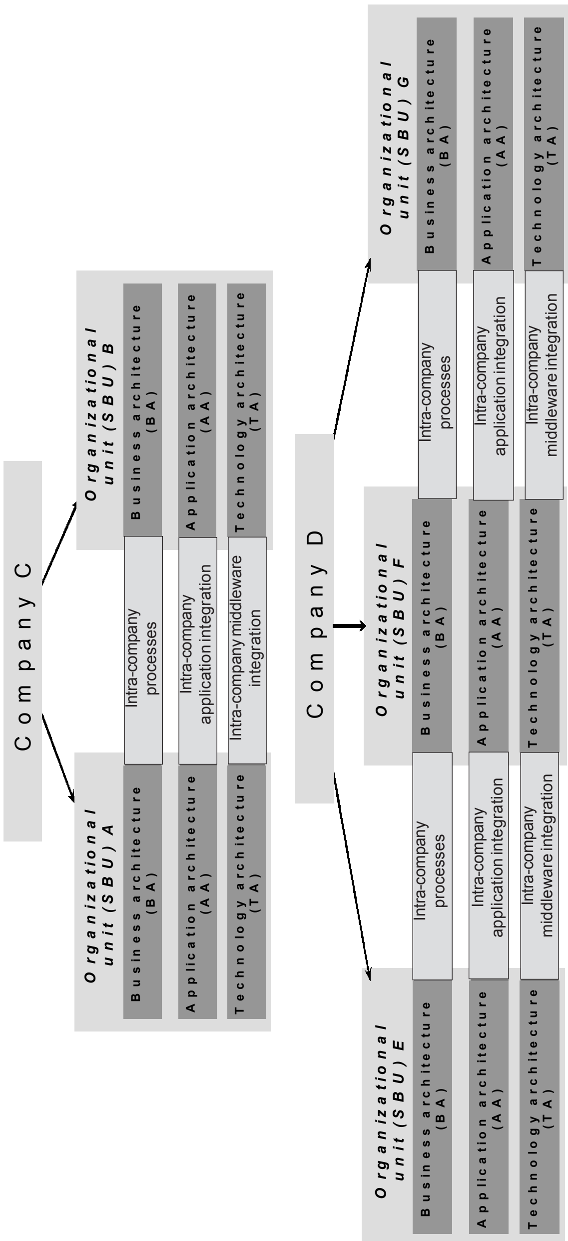


Figure 2. Intra-organizational IT integration (Modified from Hasselbring, 2000)



something valued by customerd or by decreasing costs related to the activities needed to be performed while delivering the value. For example, today the steel industry uses a lot of sub-contracting and outsourcing, while in the late 1980s and early 1990s, this was not the case. Movement towards more market coordination has forced steel companies to state and think about their process and crossover points with various players in order to employ common terms with subcontractors and other players. Common terms are needed to integrate the information systems. Internal applications can be integrated with the help of different integration applications if the business purposes and goals are visible. These include enterprise application integration systems (EAI) and Internet-enabled and messaging services (see Hasellbring, 2000; Themistocleous & Irani, 2002). The degree of integration is different in each of the technologies mentioned previously. It can be stated that depending on the EAI solution provides the deepest integration, while messaging services provide the thinnest solution, but that usually is enough. At the technology-architecture level, data gateways and transaction monitors are employed (Hasselbring, 2000). For example, old mainframe systems are complex to integrate, and thus, are usually partially integrated with a connecting layer of business language that gives more intelligence to old systems. However, as Hasselbring (2000) highlights, it is difficult to differentiate between technology-level and application-level activities.

In traditional strategic management literature, individual organizations were the objects of managerial activity; however, recently chief information officers (CIOs) and other managers have moved away from this relatively spurious thinking to a clear vision that chains of companies, value or supply chains, are competing in the modern battle for customers (Kothandaraman & Wilson, 2001). Figure 3 provides a view of IT-enabled integration within business relationships harnessed for new value creation.

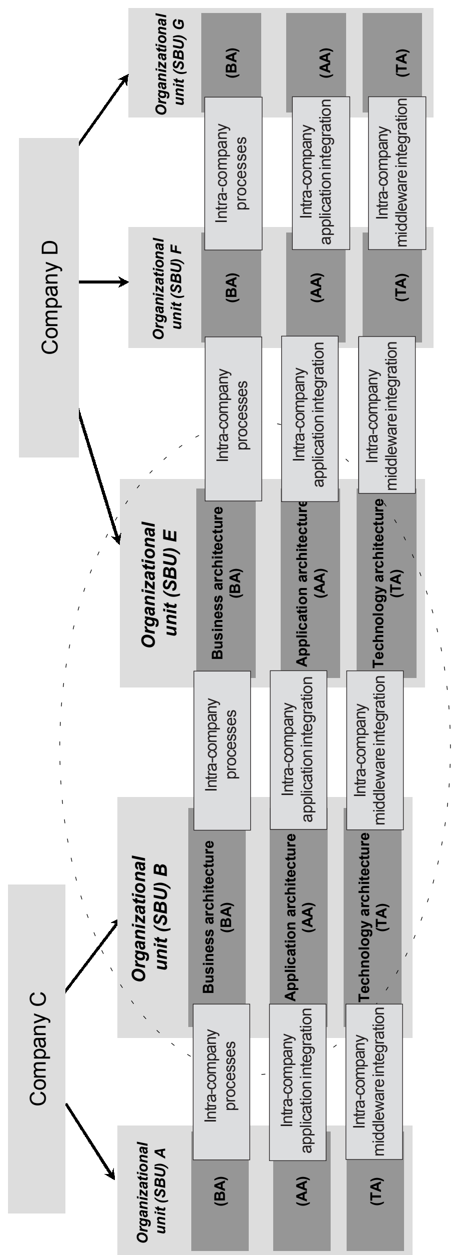
Figure 3 brings forth the discussion of IT-enabled integration of business relationships.

It is acknowledged here that not all business relationships are worth integrating, but those that are strategically important in terms of reference, relationship-specific learning and cost reduction. Numerous publications help identify strategically pertinent relationships. Figure 3 depicts a scenario in which company C and its strategic business unit (SBU) B are integrated with company D's SBU E. It is shown that before integration between these units is possible within SBU, as well as between the SBUs of companies C and D, integration needs to be completed. This is the case especially if SBUs B and E need a lot of information and support from their counterparts inside their company. For example, in the auto industry, large multinational companies are involved in numerous activities that include overlapping research and development.

Antecedents for IT Integration

To integrate a business relationship, the parties involved must possess the right amount of IT resources and skills as pinpointed by Ryssel, Ritter and Gemünden (2004). They also suggested that only strategically important relationships are integrated, as integration is relatively costly and resource consuming. To continue with the specific levels of integration in the business-architecture level, business parties agree on a common language used to describe products, services and activities that need to be carried out.

Figure 3. IT-enabled integration of business relationships (Modified from Hasselbring, 2000)



For example, parties may agree that a steel plate with dimensions 7 feet wide and 20 feet long are labeled as standard plates with code one, and so on. Also, in the offering and billing details, all the fields are agreed on—that is, what is the purpose of the field and what is input into the field. All in all, it makes business activities smoother and more effective. Once this basic way of doing business is clear, parties can ponder how these agreed-upon activities are handled in the application-architecture level. Usually, IT managers are involved in providing case-specific solutions to problems arising from the current architecture and the one that is needed to uphold agreed-on business processes.

Some of the Most Important Integration Solutions

Basically, there are two types of integration: point-to-point, which is the cheapest; and total system integration, which is more expensive.

Specific solutions to inter-organizational integration might be EDI (Mukhopadhaya, 1998), Internet-based EDI (Angeles, 2000) with extranets, electronic marketplaces, ERP integration over secured Internet (Davenport et al., 2001), Web services (Chen, Chen, & Shao, 2003), intelligent agents (Liu, Turban, & Matthew, 2000) and integration with the help of the mediator's or middlemen's service that provide connecting point-to-point integration technologies and adapters. In the technology-architecture level, the basic hardware (computers, routers, switchers) and software (basic, wrapped, enablers, messaging and integrators) is adjusted to the requirements given by the needs of the business processes.

In essence, the idea in Figure 3 is to illuminate that to integrate, parties must have common language clearly stated and based on the history of the relationship. Moreover, IT infrastructure must be created through digital processes that can be carried over and are impersonal in nature.

It is acknowledged here that information infrastructures and digital activities are missing elements in the IMP-related business relationship discussion. Thus, this chapter highlights that to fully understand business relationships, the creation of an information infrastructure and deployment of digital activities over this structure is a novel and pertinent area to study. In addition, it is suggested that information infrastructure forms the fifth element needed to understand current business relationships. Moreover, the impersonal communication or digital activities form the fifth process-oriented element missing from the IMP discussion.

We have discussed IT-enabled integration in business relationships and examined what is needed to manage integration. It should be pointed out that each of the previous integration levels must be operational before going to the next level of integration. Additional levels of integration are the business networks formed by business relationships (e.g., Salo, Karjaluoto, & Alajoutsijärvi, 2003) and, ultimately, industry standards (e.g., RosettaNet can be considered as one area of integration) (Hannula & Vasama, 2002; Shapiro & Varian, 1999). Next, we examine how IT-enabled integration impinges on the business relationship.

Changes and Challenges of IT Integration within Business Relationships

People involved in the IMP group realized in the 1970s that business marketing is somewhat different than consumer marketing, and they aimed at constructing better theories explaining marketing behavior of businesses in different contexts (e.g., Håkansson, 1982). A similar stance can be taken here, as it is obvious that business relationships have changed tremendously after emergence of Internet-based technologies. Moreover, advances in the IT field, including intelligent agents, mobile technologies (WLAN, PDA-based mobile systems) and artificial intelligence systems, are indicating that the way business relationships are currently seen is a poor conceptualization.

Thereby, it is clear that IT and IT-enabled integration changes and challenges the current understanding of business relationships. Many organizations, organizational levels, departments, IT managers and other managers, including CIOs, are involved in the decisions regarding IT-enabled integration. Besides personal contingencies, these organizational-level factors are making it complicated to integrate business relationships. Also note that all of these previously mentioned organizational levels have their own strategies and visions that hinder integration decisions.

Additionally, each of the technologies named as capable of integration in the IT field have their own characteristics that need to be mastered before information infrastructure comprised of business logic, needed applications and technology can be put together to serve the needs of the relationship. The needs of relationships can vary from cost reduction (too many administrative costs) to enhanced communication (research and development teams).

Although there are lot of downsides related to integration, many times, the positive elements are so overwhelming that the integration decision is made regarding the relationship. For example, communication and travel costs, besides other coordination costs (including administrative ones) are reduced with the help of the implemented information infrastructure that is employed to carry digital processes. Next, we provide a description of the methodology employed in this study.

Methodology

Basically, we use conceptual analysis and logical reasoning as the main research and analysis tools. In the empirical part of the study, we deploy methods that can be described as qualitative in nature. These studies have proliferated phenomenally during the 1980s and 1990s (Miles & Huberman, 1994). More precisely, a case study is employed so the researcher can collect detailed and rich information from one focal phenomenon (Woodside & Wilson, 2003; Yin, 1994). The case study offers a deeper understanding, solid contextual sense and provocation toward theory building (Bonoma, 1985; Eisenhardt, 1989). Case selection is a pertinent phase in case study research and, therefore, literature is full of advice about how to select cases (Eisenhardt, 1989; Perry, 1998; Pettigrew, 1989; Romano, 1989; Stake, 1996). Still, the decision as to how many and which cases are selected, is left to the researcher (Romano, 1989). We conduct a single case study (Cunnigham, 1997). Within the companies, we conduct several in-depth interviews with semi-structured interview questions (see Arksey & Knight, 1999: Kumar, Stern, & Anderson, 1993). The identities of the companies or the informants are not revealed for confidentiality reasons. The choice undoubtedly influences the generalizability of the results of the study (Eisenhardt, 1989) but still it is more reliable than a single case study (Yin, 1994). Therefore, the choice of case study means that this study does not aim at statistical generalization based on hypothesis testing but attempts to provide explorative ideas that can be tested later in a large-scale quantitative survey. We also used documents, meetings minutes, industry reports and branch visits to triangulate the respondents' answers and validate the results (Patton, 1987). Next, we move on to empirically illustrate the information infrastructure used in the steel industry business relationship.

A Case Study of IT-Enabled Integration of The Steel Industry Business Relationship

The field data was collected from two large European steel industry companies that have three separate business relationships between them, two of them in the steel industry context. The one that was more integrated with the help of IT was selected to be the case presented here. Eleven interviews were conducted that lasted from 1 hour to a maximum of 2-1/2 hours. Plenty of time was allowed for industry, case and interview selection. Interviews were recorded, as all interviewees gave their permission. Tapes and dictated research notes were then transcribed. Next, the case study is presented in form of a story.

Alpha is a large steel mill operating in Europe, while Zeta is relatively large workshop that specializes in heavy steel objects, welding and other special services. More than 25% of Zeta's revenues are created by Alpha's continuous need for maintenance services, specialized sub-contracting, steel hardening and investment projects.

On the buyer's side, Alpha has more than 700 internal business-specific software applications and a very complex internal information infrastructure. EAI software and point-to-point connections are used between different ERP systems owned by different sub-units of Alpha. Moreover, it has multiple CRM systems, including systems supplied by major software providers. It also has a number of selling and buying systems that can be employed. There have been attempts to reduce the number of systems, but there are still overlapping systems doing the same tasks. Much of the overlap exists due to mergers and acquisitions that took place during the 1990s and 2000s. Additionally, some parts of the sub-contracting network are planned to be integrated to Alpha by intelligent agents and artificial intelligence, but those plans have not yet materialized, although there are individual pilot projects in which those systems are tested. To sum up, the internal information structure of Alpha is rather messy but still moderately integrated, as it used to have its own IT department with more than 200 employees, but in the late 1990s, IT activities were outsourced. However, there still is a small team of IT experts divided into different sub-units of Alpha.

On the seller's side, Zeta has relatively little experience of using IT, although it has operated some basic MRP systems and is currently involved in the acquisition of an ERP system that would update and enhance its current internal activities related to manufacturing, order tracking and pricing. All in all, Zeta is less resourceful in the IT area, but due to the long common history, Alpha has guided Zeta in some IT issues.

Alpha and Zeta have been interacting with each other for more than 35 years. Here we focus on one business relationship that exists between Alpha and Zeta's hardening service sub-unit. This business relationship has a 5-year history and has faced considerable fast and extensive adaptations regarding the information infrastructure and digital processes. This business relationship is a kind of a pilot platform to conduct different kinds of IT experiments between these companies. As stated, Alpha has a strong position in IT skills and resources, and thereby, the first area that needed development was Zeta's internal systems.

At first, phone and fax machines were used to interact between the parties, but a year later, the whole process of ordering, checking capacity and the advance notification system were done digitally. Zeta bought needed hardware, established an Internet connection, built Web pages, and procured and set up needed software. These were the first information infrastructure investments. After this, traditional fax, phone traffic, and plant visits that existed between the two companies were partly directed to the Web environment. This took about 1 year, and after that, the companies realized that there were still too many manual and physical activities in the business relationship.

After this realization, Zeta also bought a small-scale ERP system from a local software company specializing in ERP systems. This was integrated over the Internet to one computer within Alpha. One of Alpha's computers, with one IP address over a secured line, was given permission to connect over the Internet to the Zeta's system. This connection also enabled Alpha to better schedule its selling of hardened products with the internal operations of Zeta. As Alpha had a real-time window into Zeta's hardening operations, it did not have to guess if it could sell more hardened products for the next week or month, as capacity and current load were available online. Moreover, Zeta increased the average amount of hardened steel plates, since almost all of the hardening capacity was sold to Alpha (almost 95% of the capacity is currently sold to Alpha). Zeta is planning to invest in new hardening plants that would allow a tenfold increase in production. Thereby, the amount sold to customers other than Alpha would increase considerably.

Both companies noticed during business relationship development discussions held annually that some processes are not yet digital. In 2004, the only non-digital activity not carried over the information infrastructure besides meetings, logistics and actual hardenings were the hardening test reports, which were printed and sent via snail-mail. First, the companies planned and implemented a WLAN-based network and employed PDAs to collect and transmit information. These were first integrated to Zeta's system with the help of a tailored software module. This module and the Zeta system provided access to Alpha's computer. With this arrangement, Alpha received test reports in real time and also had access to actual warehouse data, which eased logistic operations considerably. Moreover, Zeta has increased warehouse turnover, since Alpha now has access to real-time information and can react right away by ordering transportation from its third-party logistics provider. Figure 4 depicts the integration of IT systems over time.

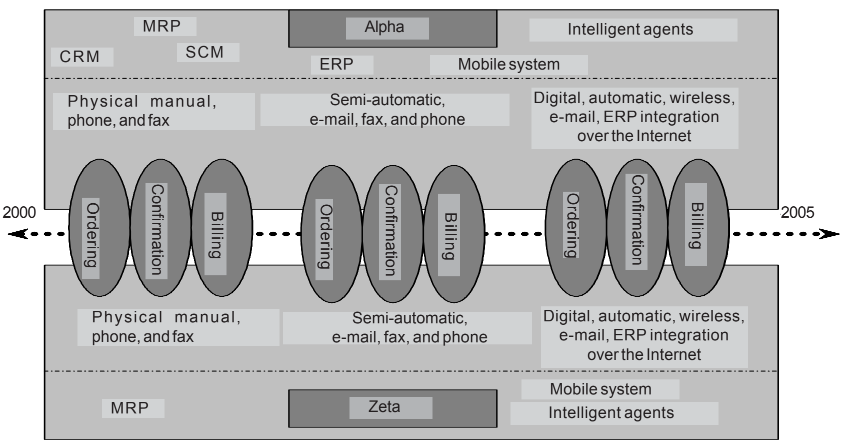
It can be seen from Figure 4 that over time, the amount of employed information infrastructure has increased and, parallel to this, the amount of digital processes has increased.

To sum up, an ERP system was integrated to one workstation of Alpha to reduce hassle relating to different physical documents as well as to speed up the information processing by providing real-time and accurate information to both parties. Information processing was further enhanced by the mobile system integrated to the same workstation.

In the future, if companies pursue further integration in some of the Alpha-Zeta relationships, it should be noted that integration with Alpha's current first-generation ERP systems, multiple CRM systems, as well as SCM systems is difficult and time consuming. Thus, it may be appropriate due to the low volume of business regarding these business relationships to use middlemen services that offer adapters and other software to integrate between these companies. This could be an affordable option to both companies, as it would not require any investment from Alpha and only a small investment from Zeta to keep up and deepen digital relationships with Alpha.

It is acknowledged that the IT-enabled integration of the Alpha-Zeta business relationship presents a rather simple integration situation, as old systems of Alpha were not fully integrated into Zeta's systems. The main goal set in the business relationship was to ease internal processes of Alpha and that goal was reached, as they now have real-time and dynamic information available needed to make both procurement and selling decisions.

Figure 4. IT-enabled integration of Alpha-Zeta business relationships



Thus, full integration was not needed. Today, also, Zeta has a good system that has reduced the amount of costs related to administrative activities and reduced the need to invest in IT systems, and has improved productivity.

Future Trends

There is a rich and diverse stream of research about both business relationships and IT integration. Future research grows in importance as companies engage in an increasing number of business relationships due to the outsourcing and sub-contracting trends in multiple industries. Thereby, both new and existing business relationships must be integrated with the help of IT integration, since it decreases existing transaction costs associated with the business relationship. In the near future, it is clear that the number of middlemen providing integration services for strategic alliances and business relationships will increase. Also, technologies related to integration will be simpler and cheaper due to the fact that the amount of technologies and services needed increases as the integration industry matures. For managers, this means simpler and easier integration of business relationships. It may be that in the future, business partners are plugged into an information platform with the help of middlemen or adapters that enable automatic, dynamic and real-time information and transaction exchanges between business parties. This also means that parties can be plugged out just as easily.

To sum up, both academics and managers are facing changes forcing them to think of IT integration not just as an internal problem but as a more holistic problem in relation to business relationships and even networks. This is because business relationships and networks in which companies are engaged are competing with other similar relationships and networks, and the only thing that may differentiate them is IT integration, which enables and facilitates effective information and transaction exchange within them.

Conclusion

This chapter has strongly emphasized that strategic business relationships truly integrated with the help of IT can provide extraordinary profits and cost reductions to both parties in the relationship. Our study highlighted that business relationship selection is critical and that internal information infrastructure is needed to uphold digitized processes. The information infrastructure was acknowledged to be the missing structural element from the IMP discussion and digital activities or impersonal communication can be identified as the missing process-oriented element.

Depending on internal technology characteristics, and integration purposes—for example, cost reduction, innovation or increasing sales—business relationships are integrated partially or totally with help of integration technologies. We described a number of technologies and empirically demonstrated with the help of a case study how integration was conducted in the steel industry, where the internal information system is rather complex and tightly wrapped. The case study also pointed out that a great many adaptations are required for integration to succeed. Additionally, it is important that many people with different positions and backgrounds are needed for the integration team.

Our study restricted attention to one steel industry business relationship with a limited integration, and this is the most severe limitation of the study. Further research should investigate the same industry with a wider and deeper integration to compare results. Based on the comparison, a large-scale quantitative study could be arranged aimed at gaining results that can be more generalized and provide more holistic explanation. In summary, we view this study as a useful foundation for further investigation of the effects of IT integration on business relationships. We hope our research stimulates additional work in this evolving but important area.

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Chapter XIV

Information and Communication Technology-Enabled Economic Growth and Convergence:
Examples from the EU's Central and Southeastern European Members

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Abstract

Globalization can be viewed as a process of increased freedom and capacity of individuals and firms to conduct economic activities with residents of other countries. The driving forces of globalization stem from the reduction in barriers for conducting business across political and geographic barriers, as well as the reduction and convergence of transaction costs via advances in "transport of information." There is a consensus that innovation and the accompanying progress in information and communication technology (ICT) serve as a catalyst for economic growth. This chapter *discusses the ICT environment within the Central and Southeastern European (CSEE) counties and the changes in this sector within the European Union (EU). Examination of strategies taken by these nations to improve their economic performance may offer decision makers in other regions some options to deal with impending changes. Particular emphasis is on the efforts of CSEE nations to build a creditable government, reliable political system, and competitive economy. These nations serve as a laboratory for implementing radical changes in their political economy from a centrally planned, one-party system to a democratic market-based system. Specific recommendations include emphasis on effectual dissemination of information between purchasers and suppliers. Information broadcasting is highly related to the creation of an efficient digital system. Specific needs include improved capacity to standardize reports, forms and information transmission functions. Furthermore, IT support and training programs are essential to reduce market distortions.*

Introduction

Over the past two decades, some developing countries have embraced economic transition policies to enter the emerging global market. An important dimension of the globalization process has been the implementation of economic policies to restructure developing nations. Many countries established greater levels of macroeconomic stability and encouraged competitive environments, as well as pursued policies promoting privatization, liberalization of trade and greater accountability (transparency of government conduct).

However, some nations experienced results that were disappointing. Many began to question the success of the restructuring programs. Economic policies sometimes failed to achieve their goals, and even exacerbated the problems of a few developing nations. For example, the so-called "Washington Consensus" pushing privatization over and above any other considerations ended up enriching only a few to the detriment of millions (as in the case of the Russian oligarchs). Reasons for failures reside in the governments' unwillingness to change and incapacity to deliver due to political conflict or domestic political leadership fallout. In this context, better governance has become critical to the establishment of an open market, transparency and an efficient public administration.

Creating a modern public procurement system is just one part of the process for an efficient and competitive market economy that is necessary for a nation's full integration into the global community. In this area, information and communication technology (ICT) can help achieve a competitive environment (open bidding) and provide opportunities for the private sector (through access to public information), greater governmental transparency and technical and market convergence; and it may even reduce a country elite's hold on the key sectors of a national economy.

Globalization and Technology

Globalization can be viewed as a process of increased freedom and capacity of individuals and firms to conduct economic activities with residents of other countries. The driving forces of globalization stem from the reduction in barriers for conducting business across political and geographic boundries, as well as the reduction and convergence of transaction costs via advances in "transport of information."[1] There is a consensus that innovation and the accompanying progress in ICT serve as a catalyst for economic growth. Qiang (2003) summarizes some research on the impact of ICT on economic growth as arising from capital deepening and increasing total factor productivity. Increased information and knowledge enable a nation to produce more goods and services. Studies have indicated a relationship in ICT investment and absorption to improvements in standards of living. However, economic growth within a nation is accomplished by more than just the magnitude of ICT activity. A nation's factors of production (land, labor, capital and entrepreneurship) are enhanced through the application of ICT tools. Thus, increased productivity of existing resources results in more global trade and economic growth. Moreover, as the G8 group of industrial nations stated, the essence of the ICT-driven economic and social transformation is its power to help individuals and societies use knowledge and ideas (Okinawa Charter on Global Information Society, 2000).

This chapter discusses the ICT environment within the Central and Southeastern European (CSEE) counties and the changes in this sector within the EU. Examination of strategies taken by these nations to improve their economic performance may offer decision makers in other regions some options to deal with the impending changes. Particular emphasis is on the efforts of CSEE nations to build a creditable government and reliable political system, and achieve a competitive economy. These nations serve as a laboratory for implementing radical changes in their political economy from a centrally planned, one-party system to a democratic market-based system. Information and communication technologies provide opportunities for governments to transform themselves as well as the way they provide products and services to citizens. This is particularly important among the CSEE nations because of the revolution to open governance and freedom of choice. Burdened by decades of inefficient systems, these nations are undergoing reorganization and reengineering. The arrival of new ICT coincides with this transformation. This technology can meet the increasing demands for public access to government information. The tools of the Internet provide a vehicle for improved information sharing among branches of government, as well as with the public.

Faced with the daunting task of serving often-cynical citizens during major transformations under conditions of a persistent lack of resources, the CSEE nations had to leapfrog into the most efficient and effective systems. The strategies, therefore, incorporated ICT. Among the potential benefits of a digital-enabled government are savings in money and time for the government, consumers and businesses. Moreover, users of government services benefit by easier access to additional, as well as higher quality, services. Most importantly, the relationship between government and citizens can evolve from its traditional hierarchical and arms-length one to a more reciprocal one, where citizens are genuine stakeholders in their government. Information and communication technologies could potentially improve the trust that citizens have in their government (Davis, 1989).

Some of the changes CSEE nations will have to implement to gain from ICT include:

- A legal and administrative framework consistent with international rules.
- Expanding education and training programs for public and private sectors.
- Greater investment in data and information systems, as well as networks.
- Strengthening the market-based economy.
- Establishing effective ethical standards to eliminate fraud, waste, abuse and corruption.

Other concerns include strategies taken to incorporate new technologies within government. Although this process is called digital government (The Center for Digital Government, 2005), implementation of ICT by itself does not mean smart government. New technologies by themselves may not provide for an open and democratic government. It is crucial that governance is itself more intelligent, not just more technologically savvy (Brynjolfsson, 1993). The move by governments to improve the delivery of services to its citizens through the use of technology—a process also called e-government (E-Gov, 2005)—typically has had a focus on technology. This has most often meant moving directly from the old paper-based system to the new digital processes. However, the objective of digital or e-government must not be limited to creating advanced systems and computer networks. According to the Okinawa Charter on Global Information Society (2000), the primary step in strengthening democratic systems is to establish policies and principles grounded in good governance, such as transparency and accountability. Moving ineffective organizations and processes into a digital environment may only perpetuate unproductive management and bloated government agencies. The traditional example of the long lines at some Departments of Motor Vehicles may serve as an example.

On the other hand, if leaders and administrators are willing and able to make governmental operations more efficient and more focused on delivering valuable services to their citizens, then technology investment and ICT operations will follow. In other words, effective administrations should have an inherent drive to seek greater efficiency and use technological solutions. Nevertheless, given the existing social, economic and infrastructure issues faced by most nations—as well as many other critical spending priorities—governments should focus initiatives on those areas most in need of change. Although positive benefits accrue from ICT investment, the competing demands for limited resources encountered by most nations means that traditional information and service delivery systems in many governmental sectors are likely to retain an important role for the near future.

The Role of ICT

Innovations and technology help solve economic development and governance problems. Moreover, these types of knowledge often are not limited by geographic or political barriers, as are many other resources. Moreover, expanding knowledge and technological advances are often quickly followed by deep price cuts. This has accelerated the widespread use of ICT across nations. The use of basic electronic mail (e-mail), commerce (e-commerce) and financial (e-banking) applications provide cost savings and time efficiency. Moreover, ICT is essential in the new knowledge-based business environment.

Investment in ICT facilitates more efficient and rapid production of goods and services. Information and communication technology products and services may help developing countries that are the most disadvantaged by poor information to complement economic policies boosting efficiency and enhancing market integration (Carayannis, 1999). According to Vu (2004), ICT contribution to growth in most economies drastically increased during 1995-2000 compared to the prior five-year period, while its variance was also strikingly widened. Although measuring and evaluating ICT impact on economic growth is difficult, research by Vu (2004) showed that accumulation in ICT capital stock is a significant determinant of the variation in output across economies. Vu also demonstrated that investment in ICT is superior to non-ICT to enhance output growth. For given levels of increase in labor and capital inputs, a higher level of ICT capital stock per capita allows a typical economy to achieve a higher output growth rate. Additionally, Braga (2002)[2] emphasizes that the new wave of globalization driven by technological advances in transport and communications technologies led to a better investment climate in developing countries since the early 1980s.

Because the use of ICT enables competitiveness and economic growth, governments play an important role in this sector (von Hippel, 1988, 2001, 2002). Therefore, policies and strategies that exploit emerging and critical technologies may offer benefits, particularly to countries in economic transition. To improve the efficiency, competitiveness and responsiveness of their governments (and hence, democratized governmental institutions), it is imperative to expand the number and variety of services, improve access to those services and address crucial issues, such as electronic procurement. "ICT can empower the disenfranchised and their intermediaries ... while promoting transparency of governmental actions and market outcomes."[3]

Various studies[4] indicate that the impact of ICT affects other sectors of the economy, not just the actual ICT industry. These include enterprises whose core activities involve the development, delivery and maintenance of ICT products and services. For example, Brynjolfsson and Hitt's (1996) analysis of United States (U.S.) firm-level data prove that ICT has a solid impact on productivity. Starting with Tom Lee and Xiao Jia Guo (1995) and through the Organization for Economic Cooperation and Development (OECD) Communication Outlook (2005) report, there is a growing consensus of research that ICT investment provides a positive spillover effect on overall economic growth. However, the quality of data in the research studies may be subject to debate[5]. Additionally, Gibbons (1995) states that competition takes place among firms, not nations. He also finds that technological activities in economic growth are positive, with the central role in knowledge generation played by corporations. Nevertheless, numerous studies of ICT investment and expenditures—as well as the corresponding productivity and diffusion indicators—clearly exhibit different effectiveness rates among nations. This is because of numerous national differences. Variations exist in their regulatory, financial, political, economic, competitive and cultural characteristics, as well in country specific technological and infrastructure factors.

Numerous government and industry programs across the world have targeted national investment in ICT. These programs are widely recognized as central to maintaining and improving a nation's competitiveness in the global economy. However, differences in the effectiveness of these programs are apparent. This is due to the assimilation of ICT investment and knowledge and not just on a particular program's design and management in acting as a catalyst for competitive advantage. Information and communication technology assimilation by a nation's citizens, enterprises and its government is thus related to overall economic vigor and productivity (Brynjolfsson & Hitt, 1996; Brynjlofsson & Yang, 1997; Triplett, 1997). Taking advantage of ICT often requires transformation and re-engineering strategies similar to those needed for opening markets and free trade. In other words, domestic policy issues influence investment and absorption rates of ICT. For example, education and training play a major role in the application of ICT benefits within the economy. Many smaller enterprises face higher costs in this area than do larger firms, because small businesses often do not have the resources or employees to take full advantage of ICT investments. This means ICT adoption is typically constrained by their level of preparedness and the firm's capability to handle the many tasks necessary for full utilization.

Changes are often required at the macro level to facilitate ICT assimilation, because nations differ in their degree of regulatory reform and competition policy. However, increasing demand for ICT utilization is fueled by the rapidly declining costs and prices for ICT equipment and services and the liberalization of the trade and regulatory framework within most nations. Globalization forces governments and enterprises to reform inefficient policies. For example, ICT-enabled price transparency exposes inefficiencies in local marketplaces, and thus, customers seek to get around trade barriers and ultimately eliminate regulations. Furthermore, as ICT lowers transaction costs, it also diminishes the advantages of vertical integration, as well as the optimal size of firms. Smaller enterprises can thus efficiently outsource (buy services from outside) on an as-needed basis. The overall economy benefits from greater cost competitiveness and ease of entry in the marketplace. Moreover, the knowledge-based economy is shortening the life cycle of products and there are continuing needs for technical, legal, organizational and social innovations among nations.

Most of the emphasis in the globalization of technology is focused on the physical products (both hardware and software) as well as on the capital invested to support a modern ICT infrastructure. However, as was noted with the problem of assimilating ICT in small enterprises, human capital is vital in sustaining ICT. Nations must produce individuals equipped with the necessary skills to develop, run and regulate the enterprises and systems that make up the ICT sector. Examples abound where developing nations have been able to leverage their ICT resources (both high-quality infrastructure and a population with ICT skills) to serve as lower-cost and more efficient outsourcing centers from developed countries. The well-known cases of India and Eastern Europe show that a so-called "digital divide" may be overcome with appropriate policies and incentives to facilitate ICT-fueled growth across the globe.

Economic Growth, Convergence, and ICT

The dramatic development in ICT across the globe has opened prospects for a virtually integrated global economy in which people can interact virtually, no matter where they are located. Information and communication technology has potential for linking existing markets leading to economic integration based on complementarities. Information and communication technology can offer less-developed nations and poor people access to markets, information and other resources that would otherwise have been inaccessible. However, globalization may also put smaller nations in a delicate situation. Technology and innovation expenditures may be so high that only a few wealthy leading nations may be in an advantageous position. Thus, there is a need to build regional collaboration and even explore cooperative agreements with large transnational companies to keep pace with knowledge-based development.

A resurgence of interest in economic growth models has sparked discussion concerning convergence, either in the levels of countries' per capita income or in growth rates of per capita income. It is also important to distinguish between the notion of absolute convergence and conditional convergence.[6] Absolute convergence predicts that countries that differ only in terms of their initial capital to labor ratio will converge to a common level of per capita income. Thus, a poor nation will eventually catch up with a rich country. However, most nations have differing starting levels of resources, thus absolute convergence is difficult to achieve. On the other hand, conditional convergence recognizes heterogeneity or differences in the economies. Unique resources—beyond their starting capital to labor ratio—means that a nation will converge to its own steady state of capital returns and income levels rather than achieve commonality with another country. Barro (1991) shows that "the hypothesis that poor countries tend to grow faster than rich countries seems to be inconsistent with the cross-country evidence, which indicates that per capita growth rates have little correlation with the starting level of per capita product."[7] This evidence indicates that cross-country data does not support the assumption that convergence applies in an absolute sense. The major reason for this finding is that economies are intrinsically different from each other. Thus, when they control for country-specific characteristics, the empirical findings for a group of around 100 countries strongly support the hypothesis of conditional convergence.

There is increased interest in economic performance comparisons. According to Stiroh (2002), the economic boom of the 1990s in the U.S. was due in part to large investment in ICT. This economic trend is often used as a benchmark to the experience of other industrialized nations and groupings, such as the long-established EU alliance, the recently enlarged EU countries, or other transition and developing areas. It is possible to expect to find no or little convergence among the transition countries. However, economic growth within CSEE nations involves second-mover ICT advantages by playing catch-up to the established industrialized nations and increasingly exhibits commonalities. According to Ark and Timmer (2003), convergence within the CSEE countries could follow the East Asian economic development of past decades. On the other hand, insufficient competitiveness and lack of innovation dissemination due to traditional regulatory frameworks with an emphasis on cost competition and protection of existing markets can inhibit economic growth (Nicoletti & Scarpetta, 2003). Fuss and Waverman's (2005) study of the "new economy" in "old Europe" supports the ICT-fueled economic growth and productivity conjecture, and they suggest that lower-productivity nations can benefit from an increase in ICT investment. A further problem is the campaign of fostering a politically motivated wedge between the "Old" and "New" Europe[8]—perhaps in an attempt to suggest a superficial divergence.

The transition process within the CSEE nations is still underway, but there remain wide variations in the level of reform and economic performance. Transition indicators over the past 10 years do not tell a single common story, but 25 separate experiences. For example, all the CSEE countries initially experienced a sharp decline in real gross domestic product (GDP). However, the magnitude and duration of the decline differed significantly across the countries. On one extreme was Moldova, which experienced an almost continuous decline in output during the period 1990-1999. On the other hand, Poland (the largest CSEE nation) had steady GDP growth with an average rate of 5% starting with 1992. These results should not be surprising, because the transition process in each country started from very different initial conditions and the speed, sequence and extent of economic and political reforms have varied widely.

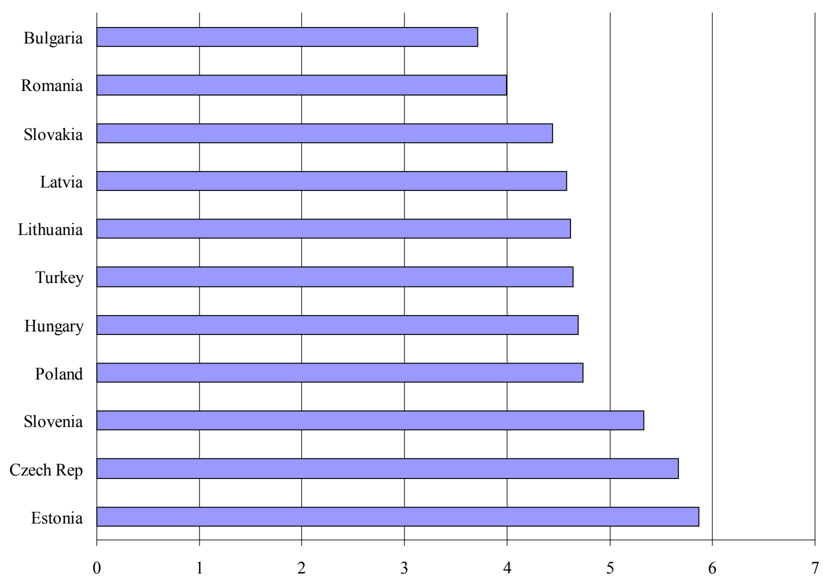
Even tempered by lingering concerns about the long-term impact of macroeconomic imbalances and other global and regional issues, there is evidence that global economic activity is now on a more steady expansion phase across most markets. A more sober mood is exhibited at the midpoint of this decade within most national economies compared to the ICT-fueled optimism and bullish attitudes so widespread in the U.S. during the 1990s. Likewise, a study by Piatkowski (2003) of the contribution of ICT to growth and productivity in Poland found a relatively large impact during 1995 to 2000. Poland's ICT investments accelerated due to rapidly falling prices of ICT products and services combined with a large demand for ICT because of its high domestic economic growth, as well as the need to overcome the underinvestment in this sector while under communist domination. The challenge posed by rapid ICT change to established regulatory frameworks and the effective assimilation of ICT tools within an economy are only some of the issues facing many nations. The implications of ICT trends have an impact on government policies and the convergence hypothesis. In part, this is due to many other national problems (such as national security, human rights, environmental protection, international trade, economic development, the surge of migration, as well as cross-border crime) that are increasingly beyond the reach of the individual countries. Similarly in the ICT arena, more institutionalized commitment and cooperation will be required on a regional level to achieve solutions and maximum benefits for economic performance.

Governance and ICT

The ideals and practices of democratic government and civil society have received widening acceptance, and hence examples such as free elections and public participation are becoming part of a global process. This agenda is being pursued throughout the world, but it has added significance among the CSEE nations because of their history. Modern liberal democratic states, however, require free elections and majority rule, as well as constitutionalism (including the rule of law, protection of basic rights and separation of power between institutions), a space free of public power for individual and group action (civil society), as well as a free market sector. So-called participatory democracy, on the other hand, postulates open public debates in search of a consensus and includes right of entry for individuals and groups to all levels of public institutions. *Rule of law* is commonly defined in procedural terms of a well-ordered legal system under an independent judiciary. Although it is a source of legitimacy, the rule of law is not self-sufficient without institutions of governance that are a direct expression of democratic self-determination. Similarly, *transparency* entails openness of proceedings and access to official documents. It supports a civil society and democracy by facilitating access to information that enables citizens to participate in public life as well as economic activities. Transparency can hold a government accountable to public opinion. It may counter "a capture" of public institutions by special interest groups. Lastly, transparency reduces a government's monopoly over economic activities. Therefore, promotion of critical thinking is one of the fundamental requirements of an open and democratic society. Citizens should be able to apply systematic and analytic reasoning allowing them to logically comprehend and solve complex concepts or problems relevant to their lives.

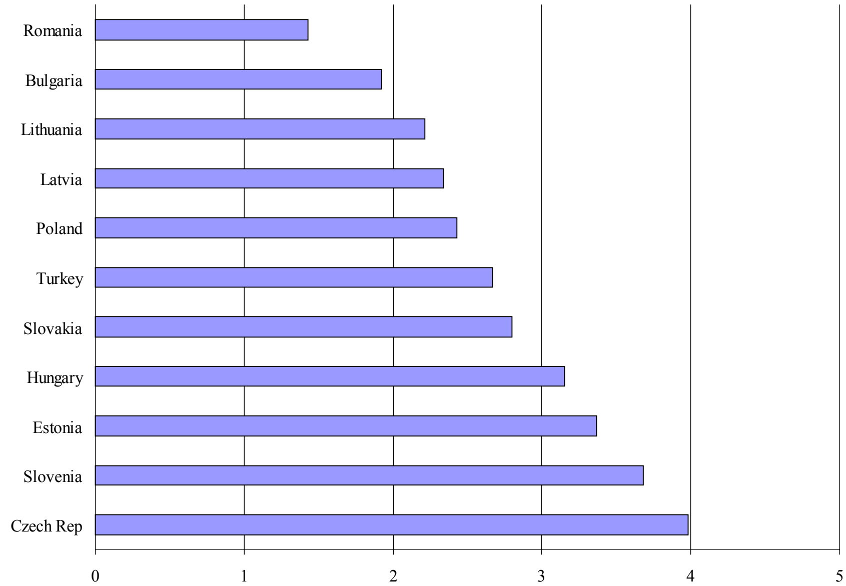
The internationalization of decision making within national states, and the expansion of the idea of civil society, has created certain pressures that emphasize the importance of integration—a process of transforming previously separate units into components of a coherent system. In this context, Information and communication technologies can serve as a tool for providing better access to information of immediate relevance to transition countries, and to facilitate market integration both domestically and regionally. The CSEE countries have moved away from the far-reaching political and economic transformation following the collapse of repressive communist systems. They are now into an era where

Graph 1. Central Europe e-government rankings (scores are on a scale of 1 to 10)



Source: EIU Report on e-government (2004)

Graph 2. E-government index: Connectivity and technology infrastructure (scores out of 10)



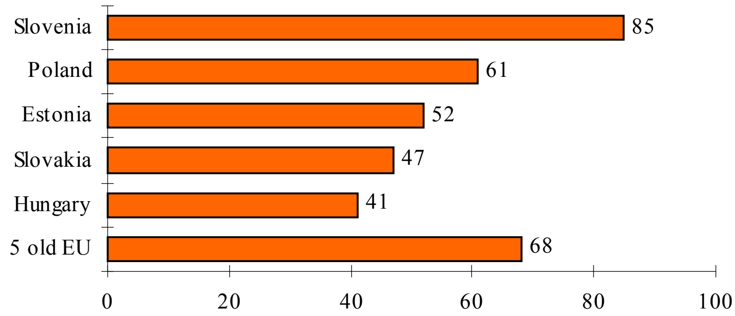
Source: EIU Report on e-government (2004)

opportunities afforded by ICT provide more than simply a new channel of delivering services. These tools offer an opportunity to achieve a quantum leap in transparency and efficiency of administration and integration.

Leaders of CSEE nations have promised their citizens ambitious goals and further developments. One of the main contributions of ICT to a democratic process of decision-making is in improving communications between citizens and their representatives, and increasing the visibility of governmental work. Many governments have already introduced online access, enabling their citizens to use of their rights. Individuals may participate electronically in government, communicate with parliamentarians or even vote electronically. In this context, ICT could create a new type of citizen, one capable of monitoring the actions of elected representatives and giving their opinion in real time on all subjects. Poland has even established a governmental Information Society Commission[9]. Moreover, unlimited and non-restricted entry to government information can increase market transparency and generate public value in other areas, such as education and health, all with enormous potential savings. In summary, ICT fosters the dissemination of information and knowledge by separating content from its physical location, and by making information, knowledge and culture accessible—in theory—to anyone. Information and communication technologies are one of the most potent forces in shaping the 21st century. Its revolutionary impact alters the manner in which people live, learn and work, as well as the way government interacts with civil society.

Information and communication technologies are fast becoming a vital engine of growth for the world economy. It is also enabling many enterprising individuals, firms and

Graph 3. Percentage of firms in selected nations that view e-commerce as significant



Source: Jerczynska, e-Facty, 2004

communities, in all parts of the globe, to address economic and social challenges with greater efficiency and imagination. Enormous opportunities can be seized and shared[10], where new technologies are effective promoters for integrating existing markets. In some cases, these changes are part of the EU accession process. Graph 2 illustrates the state of ICT infrastructure progress in CSEE based on a weighted index developed in a 2004 EIU Report.

For example, government procurement systems in most transition countries are slower and less efficient. Therefore, ICT can play in creating a more cost-effective and innovative public procurement for CSEE countries. One of the objectives of the electronic procurement is to offer international procurement opportunities to the local businesses and to improve market entry for small and medium firms that are typically specialized. Firms will be able to set up detailed alert profiles to obtain automated e-mail alerts whenever a tender notice that meets their profile appears on a particular nation's Internet procurement site. This will offer all firms a consolidated service of searchable information on both international and local procurement opportunities.

Firms within the CSEE region are rapidly embracing the opportunities afforded by ICT tools. A report by Jerczynska (2004) indicates a majority of firms in the region have Internet connectivity and, in the case of Estonia and Slovenia, already exceed the percentage of sampled firms in five "old" EU nations (Germany, France, Italy, Spain and England). Not only do a large percentage of CSEE enterprises already conduct sales and purchasing online, but according to Jerczynska, a surprisingly large number of them already consider e-commerce to be a significant aspect of their business, as shown in Graph 3.

Electronic Public Procurement

Current Practices in Public Procurement

Gershon (1999) defines procurement as "the whole process of acquisition from third parties and covers goods, services and construction projects. This process spans the whole life cycle from the initial concept and definition of business needs through to the end of the useful life of an asset or end of services contract."[11]

The key and broadly accepted principle underlying a modern public procurement system is *open competition*—unrestricted, universal access to the procurement market. In addition, the procurement process—the selection of bidders, tendering procedures and the award of contracts—should be open to public examination and review, thus making it a *transparent process*.[12] For instance, to promote transparency, the procurement process should be made open to public scrutiny. This places a heavy burden on the procurement entity within the national or local authority to award contracts that use taxpayers' money in the most efficient way possible. The transparency of the process is further reinforced when contract awards, and the overall procurement process itself, is subjected to the scrutiny of national parliaments, external audit bodies and the media.

The public procurement procedure—a significant economic activity in most countries—usually involves two kinds of players:

- Public organizations (procuring entities) that publish their intention to procure goods and services under certain rules and restrictions imposed by the government of each country.
- Suppliers (private owned business, usually small- and medium-sized enterprises (SMEs)) that respond to calls for bids indicating their intention to sell.

An open and competitive public procurement contracting procedure begins with the government's description of its requirements and an invitation to suppliers to indicate their interest in the contract and their professional capacity to fulfill it. The government then identifies potential suppliers and invites them to submit bids. The process must also make sure that suppliers can indeed meet the specifications of product quality and delivery dates and, in the case of very long-term contracts, can secure continuity of supplies. After the bidding phase, most procurement systems require a public declaration of competitors' names and their bid prices and, ultimately, of the successful bidder. A typical public procurement cycle involves the following processes: tendering, contracting and trading.[13] Tendering involves the announcement (on the procurer's side) of its intention to acquire certain goods and the submission of bids by the supplier. In specific cases, the solicitation documents may require the supplier whose tender was accepted to sign a written procurement contract conforming to the tender. The procurement contract comes into force when the procuring entity and the supplier sign it. The trading procedures involve the following actions: acquisition and after-sales report.

Public procurement may still have existing or potential deficiencies, particularly in countries with bureaucratic procedures or corruption. These include the following:[14]

- Complicated procedures and extended relationships;
- Excessive state intervention;
- Dysfunctional bureaucracies;
- Absence of clear national ICT policy;
- Large volume of paper;
- Lack of flexible centralized control;
- Lack of information quality;
- Resistance to change.

Procurement based on the use of ICT to achieve the standard of competition has the following characteristics:

- Unlimited and non-restricted access to government information;
- Increased market transparency (no barriers to entry);
- International procurement opportunities to local business and improved market access;
- Economic integration based on complementarities.

The major objective of a number of initiatives introduced in order to facilitate parts, or the whole, of the procurement cycle in the private and public sectors was to establish an electronic environment that would support public authorities and private companies, especially SMEs, in accessing procurement information and exchanging all documentation related to procurement activity.[15]

E-Procurement

Many countries have introduced electronic procurement systems first for tendering, since it is possible to make major gains in transparency and efficiency with a relatively modest investment. Tendering systems are usually operated directly by government agencies. In some countries, the service has been contracted out to a specialized agency (e.g., Australia, Mexico) and, in a few cases, to private operators (e.g., Canada, Chile). Electronic purchasing systems usually require more extensive legal and institutional changes and have been implemented only in a few countries, such as Australia and Mexico. Electronic purchasing systems would typically start after the legal infrastructure for e-commerce is in place. It can be operated either in a decentralized fashion (proprietary online catalogs) or aggregated into a larger marketplace or “exchange” (multiple vendor catalog hosting).[16]

According to the World Bank Discussion Paper on procurement, four stages are distinguished[17] for an electronic procurement system:

Stage 1	Public procurement announcement system (EU).
Stage 2	Document distribution (bidding documents) (Canada).
Stage 3	Electronic bid submission, with parallel paper process—requires pub lic key encryption and legal e-commerce infrastructure, including electronic signatures and a trust certificate authority (e.g., Australia, Mexico).
Stage 4	Full electronic processing, including online purchasing and post-bid contract management.

During the first two stages, ICT plays an important role in storing electronically the procurement cases and in establishing control mechanisms to public authorities' crosschecking capabilities. The last stages involve the adoption of electronic commerce based on the procedures and control mechanisms already established in the previous phases.[18] To allow access to information for procurement opportunities in an open market, advanced information services should be provided. This involves standard storage mechanisms, certification and authentication, as well as electronic communication and exchange of information. This is referred to as electronic document interchange (EDI). After telecommunication networks are established, the services needed for the introduction of EDI are electronic tendering, electronic contracting and electronic trading.[19]

The European Union Experience

EU Framework and Electronic Procurement

The OECD estimates that procurement purchases in EU member nations are form 10 to 15 percent of their Gross National Product (GPN or total output of the country's economy) and represent about 25 to 30 percent of all public expenditures.[20] All procurement of goods and services in the EU by public entities has to comply with the fundamental requirements of the EC Treaty of Rome[21] and, in particular, with the non-discrimination requirements. In addition, eight directives apply to the EU Public procurement. European directives[22] establish common rules for advertising procurement needs, invitations to tender and contract award. The foundation of these rules is transparency. This means universal access to the procurement market and process open to public examination and review for selecting bidders, tendering procedures and awarding contracts. The Directives impose on contracting entities obligations regarding the information to be included in the notices, the timely transmission of notices, publication in the Office of Official Publications for EC (EUR-OP) and posting into the Tenders Electronic Daily (TED[21]) database. Failure to respect these obligations renders the entity to legal challenges.

Opportunities are for contracts above the thresholds of the European public procurement directives. These directives allow three types of public procurement procedures: open, restricted and negotiated. In the open procedure, all interested suppliers, contractors or service providers may submit tenders in response to a published contract notice. In the restricted procedure, only suppliers, contractors and service providers who have been invited to participate by the contracting authority can submit a tender. The negotiated procedure allows the contracting authority to consult the suppliers, contractors or service providers of its choice and to negotiate the terms of the contracts with one or more of them, but only in cases meticulously listed in the directives[22].

The EU public procurement practice requires contracting entities to submit notices for publication. EUR-OP verifies, translates and publishes these notices in 11 languages in the Official Journal of EC and inserts them into the TED system. Thus, the procurement practices are mainly based on paper-based procedures and mail rather than instantaneous electronic communications. Because documents are transmitted by fax, postal mail and telex, problems exist for both vendors and public agencies. These problems include legibility and validity, causing delays in delivery and execution, as well as the cost of reduced competition in the marketplace. Under e-procurement, these notices could be sent by e-mail or published online. A first initiative in this respect was to replace the paper-based system of publication of tender ("S" Supplement to the Official Journal) with an electronic version of the Supplement to the Official Journal, namely the TED database, which contains procurement opportunities from contracting authorities of EU member states.

During the last decade, the European Commission has expressed its strong will to go in the direction of e-procurement through several official publications. The *Green Paper on Public Procurement* in the EU[23], issued in 1996, was the first step of the European Commission of recognizing the potential benefits of ICT in the public procurement procedure. "In the short-term, new information technologies are helping us to introduce electronic notification of tender notices and the dissemination of information to suppliers. In the longer term, the use of computer systems and telecommunications will revolutionize the way in which contracts are awarded. An 'electronic marketplace' could be developed in which suppliers list products and prices in electronic catalogs, and contracting entities could compare prices and conditions and order electronically the best value item that meets their needs. We all stand to benefit; electronic procurement will be more transparent, more open to dialog with suppliers and far more efficient than any present paper-based system."[24] The idea of a "fully electronic tendering system" is also mentioned as a system that would "cover the exchange of tender documents and tenders as well as information exchanged during the life of the contract (including invoices and payments)"[25]. However, the Commission was considering that such an implementation would not be its responsibility. It would be "a matter for the commercial judgment of contracting entities and economic operators"[26]. The objective of the *Green Paper* was not to impose major modifications to the existing EU procurement rules.

The second step towards e-procurement was the *Communication on Public Procurement in the EU* published in March 1998 by the European Commission to highlight the priorities of the public procurement policy. The Commission acknowledged that there is a need for a new framework to achieve the goal of a single market in the field of public procurement. Therefore, the EU decided to start coordinating all national procurement procedures with the goal of creating a single open market where all firms can compete for contracts on equal footing. "More efficient public procurement will not only lead to an improvement in the quality of public services, economic growth, competitiveness and job creation; but will also contribute to the fight against corruption in the EU."[27] To achieve this goal, the EC gave priority to establishing a more simplified and more flexible legal framework by "clarifying provisions which are obscure or complex and adjusting the rules in force where the problems to be addressed cannot be solved through interpretation of the provisions."[28] Furthermore, the Communication analyzed the introduction of ICT as a tool towards a more efficient way of purchasing. The goal was to achieve a substantial percentage (25%) of all procurement transactions through electronic techniques by 2003.

Following the Green Paper and the *EC Communication*, the Commission adopted on May 10, 2000, several amendments[29] known as the "legislative package" on public procurement. These amendments were intended to simplify and modernize public procurement directives. The current legal framework for public procurement is divided into eight directives, and it is very difficult to find specific information. Therefore, the Commission proposed to coordinate three main directives (supplies, works and services) into a simplified single directive. The Commission also wanted to introduce a modernized and flexible procedure by allowing the use of ICT in the public contract process.

In addition to preparing legislation and encouraging standardization at the European international level, the European Commission launched the Système d'Information des Marchés Publiques (SIMAP) government procurement information system (http://simap.eu.int/). It aims "to support an effective Single Market by encouraging suppliers and contracting entities to adopt best practices and use electronic commerce and information technology to provide all the information needed to deliver value for money in public procurement."[30] This Internet site became the catalyst to incorporate ICT in the public procurement procedures. Initially, SIMAP was designed to address the provision of information about the EU procurement opportunities to all interested suppliers. Its longer-term goal was to address the whole procurement process—including bids, award of contracts, delivery, invoicing and payment.

Key Lessons Learned

The EU experience demonstrates that ICT poses a number of major challenges and costs. Since technology is changing at incredible speeds, investments in technology are perceived to be an important cost factor. It is difficult to invest wisely in a field that is evolving so fast and where systems can become obsolete almost overnight. Another problem is the difficulty to find and keep the highly skilled personnel required to maintain complex ICT systems.

Other challenges exist in the move to e-procurement. A number of key findings can be drawn from the experiences of the EU in developing and introducing new electronic government services:

- E-procurement is one of the main priorities in e-government initiatives in the EU.
- Investments in technology are perceived to be an important cost factor for the European Commission.
- Highly skilled personnel are required to maintain complex ICT systems.
- Participants in the public procurement market must have computers with Internet access.
- Tender opportunities must be widely and internationally publicized to attract adequate numbers of qualified suppliers and ensure transparency.
- Transparency of the EU public procurement market was improved by a systematic use of electronic notification and dissemination (developed within the SIMAP project).
- Standards play a critical role in opening up markets.
- An efficient information system is a prerequisite, with standardized forms and notification, to improve the process, quality and information flow.
- The involvement of the private sector in the design, planning and management of e-procurement projects is very important.
- The security aspects, such as encryption and digital signatures, are particularly important for the development of a more advanced e-procurement system.
- Information support and training programs are essential to reduce barriers (accessibility problems, lack of knowledge and low user acceptance).
- A totally electronic procurement process integrating ICT will only be possible if all member states work closely together and allow the private sector to provide experience and the necessary infrastructure, and become involved in the process.
- It is critical to use information on international best practices, such as "benchmarking" techniques that compare the performance of different procurement entities.

CSEE Nations and Electronic Procurement

Central and Southeastern European nations have been working to establish modern public procurement systems from the beginning of their transition to a market economy. Creating such systems is part of the process of forging an efficient, competitive market economy and is necessary for these countries' full integration into the international trading community.

However, building and implementing the system entails significant changes from the days of the command economy, when procurement was part of the central planning system. In particular, CSEE nations must[31]:

- **Design a legal and administrative framework** that facilitates the integration of myriad procurement entities throughout the public sector into a functional and coherent network with high professional standards, and that is consistent with international obligations. Such a framework should define the financial and legal responsibilities of all participants in the procurement process, including suppliers and procurement entities in central and local government.

- **Ensure that government purchasing entities employ trained personnel** who understand the need for efficient procurement systems. Creating these systems generates significant training costs. Democracies with advanced market economies and well-developed procurement systems generally commit more resources to procurement training than do central and eastern European countries.
- **Invest heavily in systems** that provide adequate access to data and information, and which facilitate professional networking within the public sector.
- **Give suppliers access to training and information** that promote their competitiveness, which in turn strengthens the market economy.
- **Design and implement effective mechanisms to curb fraud, waste, abuse and corruption**, which threaten public procurement systems in all countries and impede competition. [32]

A key element in the pre-accession phase is the alignment by the CSEE governments of their legislation with EU legislation governing the single market.

The use of ICT will have considerable effects on the way public procurement is organized in the transition economies. This includes decisions on how the governments in these countries intend to create a marketplace for government procurement information such as tender notices, contract awards, bidding documents and so forth. Policy makers should be guided by principles that contribute to increased transparency and efficiency in government procurement by providing state-of-the-art e-procurement solutions. However, some e-procurement opportunities and challenges faced by the CSEE nations include: (EIU Report on E-Government, 2004):

- An inadequate ICT infrastructure in homes and workplaces continues to be an impediment to e-government progress in some regions. Advanced online public services are not worthwhile if many citizens cannot access them. Although mobile voice services are well developed, reliable broadband service is still slowly expanding.
- Several of the CSEE governments have moved ahead in e-government vision and purpose, as well as developed an efficient strategy development and implementation. Although held back by connectivity problems, Estonia, Slovenia and the Czech Republic have gone well beyond e-government posturing and compare favorably in many areas with the rest of the EU, particularly in shifting public service delivery online. For example, Estonia has made significant gains in soliciting digital feedback from citizens.
- The combination of growing online service sophistication with poor infrastructure creates a socio-political risk for the CSEE nations. The influence of the infrastructure "haves" (essentially, the current political and business elites) expands and

becomes entrenched. The result is a widening of the digital divide, rather than progress toward a greater democratization and transparency resulting from the benefits of ICT resources.

Conclusion and Future Research

The ICT sector, infrastructure and services provide a fundamental underpinning for today's information economies. Moreover, ICT induces structural changes within and between nations, as well as enables goods and services to move freely, thus fostering competitiveness. Information and communication technologies also have a central role in enhancing total factor productivity within domestic economies and their employment growth. Therefore, national policy makers should consider the experience of countries that have been the most successful with ICT use within their economies.

The chief characteristics to achieving success in harnessing ICT include the continued liberalization of markets, an independent regulatory system, full acceptance of new technologies that destroy existing institutions and relationships, as well as promoting and developing the required human capital necessary for ICT operations. The goal of policy makers should be to establish an environment where ICT can flourish on its own without intervention. Proper markets and infrastructures may then create a virtuous cycle of economic development, where incomes improve and ICT increases spontaneously[33]. Numerous studies highlight that the ICT sector has an increasingly influential role in economy-wide productivity growth and technological diffusion.

There is evidence that continual improvements in ICT provide the opportunities to make public procurement for goods and services more transparent and efficient. It is clear that an effective public procurement policy is fundamental to the success of the EU single market in achieving its objectives. Public procurement goals include generating sustainable and long-term growth as well as creating jobs and fostering the development of businesses capable of exploiting the opportunities generated by the single market, as well as a capability to compete in global markets and provide taxpayers and users of public services with best value for their money. The experience in the EU's governance demonstrates that the impact of ICT affects not only the public's expectations with the way government performs its tasks, but also provides a better way for government to improve its ability to meet these heightened expectations.

Most of the CSEE nations appear to have the basic principles of ICT regulation and public procurement processes in place. This has created a foundation for e-government evolution. Some, such as Estonia, Slovenia and Czech Republic, have tailored their e-government plans to serve the broader objectives of better government and economic transformation. Estonia's e-government implementation efforts, for example, have gained significant attention. The initiatives have been thorough and innovative, and seem to have come from a basic strategy of government—to improve the country's economic prospects. The Estonian and Slovenian governments have made conscious decisions to use government coordination and initiatives to transform the ways in which the state provides services. These initiatives provide platforms for domestic business to succeed.

A good template is the EIU Report (2004) that draws a parallel with these small and relatively resource-poor nations to the successful development pattern established by Singapore.

Specific recommendations include emphasis on effectual dissemination of information between purchasers and suppliers. Information broadcasting is highly related to the creation of an efficient digital system. Specific needs include improved capacity to standardize reports, forms and information transmission functions. Furthermore, ICT support and training programs are essential to reduce market distortions. For example, technology enables a government entity to draft procurement notices in an Internet interface, tag them with a standardized terminology and directly electronically publish them. Specialized staff procurement expertise can thus be concentrated on establishing commercial arrangements rather than operating inefficient manual contract management and delivery systems. On the other side, suppliers are able to make detailed searches, set up business profiles and obtain automatic e-mail alerts whenever a procurement notice matches their business profile. Thus, government agencies make purchasing contracts with suppliers on the basis of the more assured demand they can obtain.

The EU experience indicates additional research should be based on the identification and rating of the perceived costs and benefits of projects, and should address the following questions:

- What are the barriers to greater open competition, transparency, disclosure of information and accountability for the target countries in CSEE?
- What are the main costs and factors of e-procurement in the CSEE region?
- What are the start-up costs compared to the operation costs?
- What are the direct, indirect and strategic benefits of e-procurement for governments and the private sector?
- What is the overall benefit ratio of e-procurement compared to the traditional paper-based procurement process in the context of economic transition?

Such analysis will allow comparing qualitative intangibles in a manner that may indicate the most cost-efficient option; in particular, in cases where cost and benefit analysis is not possible due to the lack of or the qualitative nature of data and projects, such as transparency, responsiveness and democratic nature of government services and functions. Future research ought to consider the necessary sequential steps that governments should undertake to implement electronic procurement, such as defining a legal and organizational framework, design systems for availability and dissemination of procurement information.

Information and communication technologies will continue to change the way information and public procurement is organized in transition economies. Greater transparency and efficiency in e-government operations and procurement will achieve better performance while necessitating greater commonalities across these nations, thus contributing to increasing convergence.

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1. Braga, C.A. et al. (2002, March). *Globalization and technology: You can't put the genie back in the bottle again* (p. 3).
2. Ibid., p. 7
3. Ibid., p. 3
4. There are many studies that use (1) growth accounting to capture the contribution of ICT to output growth and labor productivity at the national level; (2) analysis at the industry and firm levels, where a combination of growth accounting methods and econometric models examine a sample to isolate the impact of ICT on their growth and productivity; (3) non-growth accounting approaches, such as econometric models with national panel data to measure the effect of ICT on growth and productivity; and (4) case studies to show that ICT within a country, sector, industry or locality had an impact on income, growth or productivity.
5. OECD investment data for ICT are extracted from the System of National Accounts (SMA), but the SMA guidelines have not been fully implemented in all nations. See *A New Economy?: The Changing Role of Innovations and Information Technology in Growth*, OECD Directorate for Science, Technology and Industry, May 25, 2000.

[6] See Woods (2006) for a detailed discussion of economic growth models and convergence examining the evidence of regions within California in "Re-Discovering Schumpeter: Creative Destruction Perspectives on Creativity, Invention, and Innovation, Diffusion and Impact" by Carayannis and Ziemnowica.

[7] For graphical illustration of this correlation, see Robert J. Barro (1991, May), Economic growth in a cross section of countries, *Quarterly Journal of Economics, 106*(2), 408, 415.

[8] Most often attributed to Donald Rumsfeld, United States Secretary of Defense, as well as others in the George W. Bush administration.

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[19] Ibid.

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[21] See http://europa.eu.int/abc/obj/treaties/en/entoc05.htm

[22] See full text: http://europa.eu.int/scadplus/leg/en/s11000.htm

[23] See http://ted.eur-op.eu.int/

[24] See Guide to Community rules on public supply contracts, ch. 3: http://simap.eu.int/EN/pub/docs/gsuplen.htm

[25] See: http://simap.eu.int/EN/pub/docs/gpen.htm

[26] Ibid.

[27] Ibid., p.26.

[28] Ibid.

29 Commission communication of 11 March 1998: Public procurement in the European Union

30 Ibid.

31 See http://europa.eu.int/comm/internal_market/en/publproc/general/com275en.pdf

32 See http://simap.eu.int/EN/pub/src/welcome.htm

33 SIGMA Policy Brief No. 3: Public Procurement. (1997, December).

34 ibid.

35 See OECD reports: *The New Economy: Beyond the Hype* (2001) and *ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms* (2003).

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