An Interdisciplinary Perspective on IT Services Management and Service Science

INDRANIL R. BARDHAN, HALUK DEMIRKAN, P.K. KANNAN, ROBERT J. KAUFFMAN, AND RYAN SOUGSTAD

Indranil R. Bardhan is an Associate Professor of Management Information Systems and Accounting and Information Management at the University of Texas at Dallas. His research interests are in the areas of information technology valuation, business impact of information systems on supply chain and firm performance, and health care informatics. His research has been published in leading journals, including *Information Systems Research, Journal of Management Information Systems, MIS Quarterly, Operations Research, Manufacturing & Service Operations Management, Production and Operations Management, European Journal of Operational Research, Annals of Operations Research, Journal of Productivity Analysis,* and *Journal of the Operations Research Society of Japan.* He has ten years of management consulting experience and has advised Fortune 500 executives on information technology strategy and systems implementation.

Haluk Demirkan is a Clinical Associate Professor of Information Systems and a Research Faculty member of the Center for Services Leadership at the W.P. Carey School of Business at Arizona State University. He has a Ph.D. in Information Systems and Operations Management from the University of Florida. His research in service science and service-oriented management and technology solutions has included recent industry-sponsored research projects with American Express, Intel, IBM, MicroStrategy, and Teradata. His research appears in a number of journals, including *Journal of the AIS, European Journal of Operational Research, IEEE Transactions on Systems, Man, and Cybernetics, Electronic Commerce Research and Applications, Information Systems Frontiers, Communications of the ACM, Information Systems and E-Business Management, International Journal of Services Science,* and other leading journals. He has 15 years of consulting experience in the areas of service-oriented solutions, information supply chain, business intelligence, and strategic business engineering with Fortune 100 companies. He is the recent recipient of the IBM Faculty Award for a research project titled "Design Science for Self-Service Systems."

P.K. Kannan is a Professor of Marketing in the Robert H. Smith School of Business at the University of Maryland. He is the Director for the Center of Excellence in Service. His research focuses on new product/service development, design and pricing of digital products and product lines, marketing and product development on the Internet, e-service, and customer loyalty. He has received several grants from the National Science Foundation, Mellon Foundation, Science Applications International Corporation, and PricewaterhouseCoopers. His work has been published in *Marketing Science, Management Science, Journal of Marketing Research, International Journal of Electronic Commerce,* and *Communications of the ACM.* His research won the John Little Best Paper Award (2008) and the INFORMS Society for Marketing Science Practice Prize Award (2007). He serves on the editorial boards of *Marketing Science,*

Journal of Management Information Systems / Spring 2010, Vol. 26, No. 4, pp. 13–64.

0742–1222 / 2010 $9.50 + 0.00.
DOI 10.2753/MIS0742-1222260402

Journal of Marketing, Journal of the Academy of Marketing Science, International Journal of Electronic Commerce, and *Journal of Service Research.*

Robert J. Kauffman is the W.P. Carey Chair in IS at the W.P. Carey School of Business, Arizona State University, where he holds appointments in IS, Finance, Supply Chain, and the School of Computing and Informatics. He has served on the faculty at New York University, University of Minnesota, and University of Rochester. His research interests span the economics of IS, competitive strategy and technology, IT value, pricing, supply chain management, and theory development and empirical methods. He has published in many leading journals and won outstanding research awards from the IEEE, Association for Information Systems, INFORMS, International Conference on Electronic Commerce, and Hawaii International Conference on System Sciences in the past five years.

Ryan Sougstad is an Assistant Professor of Accounting and Business Administration at Augustana College in Sioux Falls, South Dakota, which he joined in summer 2009. He spent seven years with IBM in client sales and marketing and at IBM Research's Business Informatics group. He holds a B.A. from the University of Kansas, an MBA from UT Dallas, and a Ph.D. in IS from the University of Minnesota. His research on the valuation and risk management of IT-enabled services has appeared in the *Journal of Management Information Systems* and *International Journal of Services Science.*

Abstract: The increasing importance of information technology (IT) services in the global economy prompts researchers in the field of information systems (IS) to give special attention to the foundations of managerial and technical knowledge in this emerging arena of knowledge. Already we have seen the computer science discipline embrace the challenges of finding new directions in design science toward making services-oriented computing approaches more effective, setting the stage for the development of a new science—*service science, management, and engineering* (SSME). This paper addresses the issues from the point of view of service science as a fundamental area for IS research. We propose a robust framework for evaluating the research on service science, and the likely outcomes and new directions that we expect to see in the coming decade. We emphasize the multiple roles of producers and consumers of services-oriented technology innovations, as well as value-adding seller intermediaries and systems integrators, and standards organizations, user groups, and regulators as monitors. The analysis is cast in multidisciplinary terms, including computer science and IS, economics and finance, marketing, and operations and supply chain management. Evaluating the accomplishments and opportunities for research related to the SSME perspective through a robust framework enables in-depth assessment in the present, as well as an ongoing evaluation of new knowledge in this area, and the advancement of the related management practice capabilities to improve IT services in organizations.

Key words and phrases: cloud computing, economics, IS, IT services, literature survey, marketing, operations, research directions, service science, services management, services-oriented systems, system science.

Most organizations today depend on information services that are facilitated by information technology (IT) [186]. Services-oriented thinking is one of the fastest-growing paradigms in technology management, with relevance to many other disciplines, such as accounting, finance, marketing, computer science, information systems (IS), and operations. According to Babaie et al. [11], worldwide end-user spending on IT services will grow at a 6.4 percent compound annual growth rate through 2010 to reach $855.6 billion, with positive growth in nearly all market segments. International Data Corporation (IDC) estimated that the spending on the software-as-a-service (SaaS) market would significantly grow to $10 billion by 2009 [45], experiencing a 138 percent increase from $3.6 billion in 2005 [125]. It further estimated that spending would grow to more than $33.8 billion by 2010, almost ten times what was spent in 2005. Plummer et al. predict that at least one-third of business application software spending will be on SaaS, instead of as product licenses by 2012 [187]. Also, 40 percent of capital expenditures will be made for *infrastructure-as-a-service* (IaaS) by 2011. In addition, Forrester Research indicates that companies implementing a *service-oriented architecture* (SOA) are typically able to reduce costs for the integration of projects and maintenance by at least 30 percent [232].

A critical enabler of this growth is the convergence of different kinds of IT. Growing knowledge with respect to IT-related design, execution, storage, transmission, and reuse is creating opportunities for organizations to configure services relationships that create extraordinary new value [47]. IT helps to improve the efficiency, effectiveness, and innovativeness of organizations. It makes this possible through the commoditization of noncore competencies, including outsourcing and other forms of external services acquisition. Another improvement comes through value-adding collaboration supported by new inter- and intraorganizational workflows and business processes made possible by IT [144]. Another beneficial effect is decreasing the risk of information security breaches. We see entirely new types of services being facilitated, including Internet search, mobile ticketing, digital wallets, biometric security capabilities, and mobile medicine applications.

Other developments involve the separation of production and consumption of services, so multiple organizations can be involved in adding value [47]. Related to this are capabilities that support storage, transport, and access to knowledge-based services. These include online university courses, Internet tax filings, and multifirm sharing of risk management data. Additional efforts have gone toward coordination of services systems, including online brokerage systems, information and opinion markets, and open innovation platforms, which have the capacity to change the business processes of the past for a new, higher-technology future. We have also seen reductions in the costs of services production, with semiautomated and fully automated call centers, digital delivery of surveys and information to customers, and after-sale warranty services and customer support. Improvements in customer-perceived services quality have also been occurring with the IT-enhanced ability to standardize elements of services, and to more flexibly customize them [69]. Another area of beneficial effects comes from the integration of customer operations in support of services creation and delivery, as we have seen in business-to-business (B2B) activities such as electronic procurement, co-production of services, new product development, and security services design [161].

Although services-oriented thinking is a growing paradigm, scholars from different functional perspectives have investigated the challenges of services independent of one another. This includes IT services and computer science, economics and financial analysis of services, services marketing and management, services operations and supply chain management, and human resources. The ideas have grown with the availability of theories, tools, and methods of the individual disciplines. As firms attempt to remap their offerings from goods to services, to increase value for their customers, to rethink strategies and structures, and to transition to services management for their portfolio of resources and capabilities, functional perspectives alone are insufficient [186]. Instead, interdisciplinary and cross-disciplinary approaches are required to understand how services should be designed, delivered, and supported.

Current research in IT and computer science has examined issues in decision support services environments [107], services management [64], service-level agreements [24] and negotiation processes [26], knowledge management, business valuation, enterprise modeling, business process analysis, and applications services. Most services-oriented technology research focuses on service-oriented architectures with the use of data grids, Web services, grid services, component technology, middleware, and agent technology to create a technical architecture that orchestrates software services into applications and an infrastructure that supports services consumer needs [180, 217]. A large portion of the SOA literature describes specific applications: network services [77], digital libraries [225], data mining [48], and health care [53]. Other literature examines SOA development and implementation issues, such as service-level agreement management [176], and enterprise services. These studies assess the means for the success of SOA implementations. Also, there is a growing research awareness of developing new types of decision support infrastructures that link lower-level architecture to virtual support environments [107].

New business applications require effective valuation to support investment decision making. There are many valuation methods, but recently new decision making under uncertainty approaches have gained attention. Their limitations are apparent in their inability to address some sequential investment decisions, including ongoing service-level agreement negotiation in co-sourcing contexts [74]. The managerial needs create the impetus for exploring theory-based approaches from economics and finance to improve the organization's control of services-oriented technology and management activities.

Researchers in services marketing have been analyzing customer-defined service quality, satisfaction and loyalty, participation in services delivery, and lifetime value [159, 231, 238]. Services culture and climate, employee empowerment, hiring and training services employees, and incentives have also been considered. Some studies related to services-oriented operations and supply chain management estimate the economic impact of data quality problems. They also evaluate the effectiveness of radio frequency identification (RFID), determine control policies that perform robustly in systems with less-than-perfect data, and promote development of decision support frameworks to accommodate the diverse concerns of geographically dispersed entities across the supply chain [169]. Difficulties arise with the presence of uncertainty in demand, capacity, transportation and manufacturing time, costs and quality, and priorities [35]. Other concerns include the effects of missing or ambiguous information and the bullwhip effect.

Meanwhile, the world economy is transitioning from a goods-based economy to one of value creation, employment, and economic wealth dependent on services [220, 221]. According to Pal and Zimmerie [178], services account for 75 percent of U.S. gross domestic product (GDP) and 80 percent of private-sector employment [135]. The Organization for Economic Cooperation and Development (OECD) countries are also having this change. As described by Friedman, globalization has created a *triple convergence* of "new players, on a new playing field, developing new processes and habits for horizontal collaboration" [100, p. 175]. This has resulted in an explosive opportunity for countries all over to participate in global value chains, where services are increasingly essential. A silo-based approach to research and education within disciplines that are critical to this new approach of conducting business and addressing societal needs is untenable, as a result.

Rai and Sambamurthy [189] stated that the growth of services-oriented IT innovations, coupled with the shift from goods to services, will yield many opportunities for IS researchers to investigate behavioral, economic, technical, and organizational issues. In this paper, our intent is to build on the core foundations related to IT and the services orientation. The relevant research culture is characterized by a cross-disciplinary attitude, recognizing that fulfilling client needs is the primary objective. A related attitude is an awareness of the complexities associated with service trade-offs and the associated decision making involving value, risk, and cost.

We present a robust framework that supports our evaluation of theory and methods for the management of services-oriented systems.[1] Then we initiate our exploration of the issues and opportunities for new managerial knowledge for services-oriented systems through the computer science, design science, and IS and technology perspectives. The discussion in the fourth and fifth sections considers the economics and financial economics of services-oriented systems and the applicability of leading theoretical perspectives that suggest where new foundational knowledge for the emerging discipline of service science can be developed. Then we consider perspectives on service science developed by services marketing and logistics and operations and supply chain management researchers. In both disciplines, services-oriented approaches have been shown to be critical to organizational performance.

Evaluating Theory and Methods for Services-Oriented Systems

In the development of a survey of current thinking and research directions related to theory and methods that will come to define a new area of exploration in academic research, it is important to work from a set of organizing principles that will find widespread agreement among university researchers and industry practitioners for their relevance in the present and their continuing applicability in the future. In this paper, we view the new paradigm, the related emerging practices, the fresh theoretical perspectives, and the promising methodologies as arising around a disruptive technological approach for computing and systems in organizations—the *services-oriented systems paradigm* [123]. Our perspective emphasizes (1) the multiple roles of different *stakeholders,* (2) the *effects* of the technological changes that are under way, and, (3) where different *theories* are likely to find an important place in the foundational knowledge of this emerging discipline, possible new research directions.

A *robust framework* offers a means for analyzing technological innovations in a manner that aims to provide *validity* over time and across different environments and settings [9, 142]. The property of *robustness* has the multiple connotations of standing the test of time, enduring in the face of changes in the marketplace and technology, and being continuously useful even with the passage of time. It offers the capability for an observer to evaluate the effects of technology, the efficacy of different theoretical perspectives, the appropriateness of alternate firm strategies, and thus the usefulness of various theories when some of the conditions of a setting are changing.

Utilizing a robust framework for analyzing these issues—services-oriented systems and service science—offers an unusual opportunity for laying down some key conceptual foundations, initiating perspectives for business school research, and defining some of the important elements of the future agenda for studying key issues in this area. In this context, a *disruptive technology* is a technological innovation that changes the market and industry infrastructure; gives rise to new business processes and software applications; and supports the displacement of current technologies, products, and services while creating a new basis for products, services, infrastructures, and applications that will become dominant in future markets [50, 51].

We will leverage the proposed robust framework to provide a basis for analyzing how services-oriented systems and service science will act as a disruptive technological innovation that will have effects on four kinds of stakeholders. A *stakeholder* is an agent that is able to effect change through its own actions with technology, or is affected by a technological innovation and the related products and services changes due to the actions of another stakeholder. These kinds of things occur within technology ecosystems [1, 2]. The effects of changes that occur may be more or less readily observed, depending on the specific *impact dimension* considered. The resulting changes involve consumer utility, business processes, managerial practices, and welfare. An *agent* may be a consumer, user, buyer, innovator, producer, vendor or sales and consulting intermediary, government regulator, user group, standards organization, and so on. *Stakeholder roles* can create effects or will be subject to being affected by the technology disruption.

Typical stakeholders have private profit incentive–driven and social welfare–driven considerations related to the economic, organizational, human, and technological issues that may arise. Our term *stakeholder* differs from its usage in economics and finance. In those disciplines, a stakeholder is an agent that has some financial or other interest in a firm (www.thefreedictionary.com/stakeholder). This includes relationships involving the local community, as in the case of utilities, and the regional and national government, which may have an interest to regulate some activities due to technological innovation.

Figure 1 shows our framework as a *stakeholder circle.* It emphasizes stakeholder roles and the extent to which one stakeholder's interests differs from another's. On

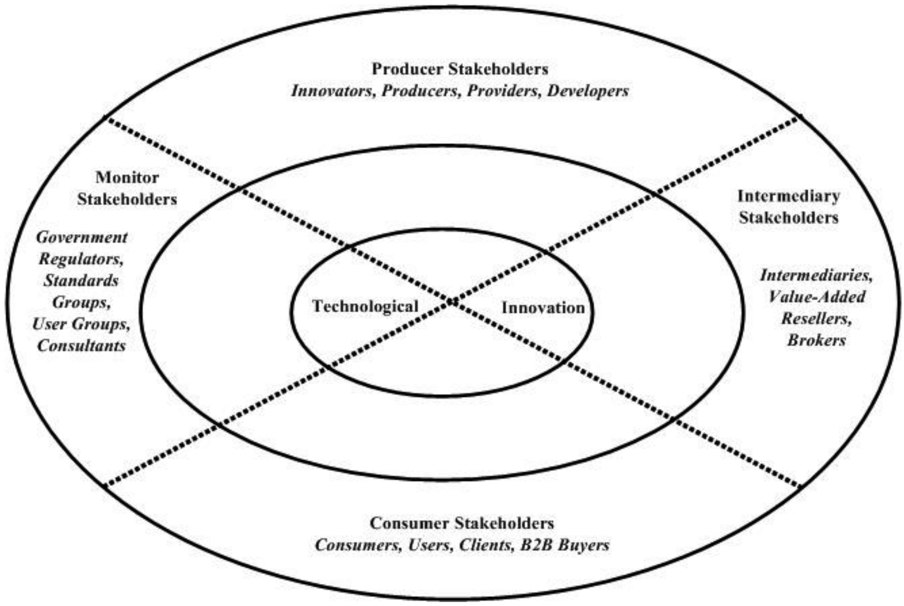

Figure 1. A Stakeholder Framework for IT Services Management
Notes: A disruptive technological innovation enters the environment at the epicenter of the circle. The ripples (outer circles) affect stakeholders that are arrayed around the point of the first disruption, illustrated by the large and innermost circle. The *producer stakeholders* and the *consumer stakeholders* have somewhat opposing goals; for example, buying at a low price versus achieving a value-maximizing payback on a technological innovation. The same is true for the *intermediary stakeholders* and the *monitor stakeholders;* one is interested in adding value to the intermediation process between producers and consumers, while the other is interested in regulating or standardizing the intermediation process so that the highest social welfare is achieved.

the top, we have the *producer stakeholders,* whose actions have resulted in the new technological solutions and business practices associated with services-oriented systems and service science. These stakeholders are technology and IT services firms; consulting firms; government, industry, and university research labs; and commercialization programs. They are involved in the development of intellectual property related to products and services. On the bottom are *consumer stakeholders.* They are opposed in their interests to what the producers and innovators wish to achieve. They are customers, clients, and users of the technological innovations. They have cost minimization and revenue maximization as a basis for profitability on their minds. Kauffman and Walden [142] have characterized these contrasting stakeholder roles as *value makers* and *value takers,* as they are at opposite ends of the spectrum of production and consumption.

The picture is incomplete without considering some other key *intermediaries and third-party stakeholders.* Situated between the innovators and producers of service science innovations and the users and consumers who purchase them, another class of organizational stakeholders paves the roads and builds the bridges for economic exchange. The *intermediary stakeholders* are IT and technology vendors that obtain rights to the technological innovations, from innovators and producers, to be marketplace and value-added resellers of derivative products and services that acquisition of the relevant intellectual property permits. They include large and small technology solutions vendors and value-added resellers and consulting firms that refine the innovations of other firms for the market distribution of IT services. They are *intermediaries* in the classical sense of market economics: without their involvement and intermediation, the economic value of exchange would be less than if they were involved, such that there is room for them to earn an economic profit for the intermediation services that they offer [223]. They also support value creation, smoothing the path for consumer adoption, acceptance of new selling, and movement to the global sourcing of capabilities that are necessary to make the innovations economical.

There is another class of intermediaries—the *monitor stakeholders* (the "monitors")—that act as welfare-supporting representatives for society and the business arena. They are third parties and do not play a direct role in buying or selling, although they may represent other stakeholders. Their value comes from the representation they provide so that other stakeholders' interests are preserved: producers to continue to innovate in the targeted technology area, vendors to sell unfettered in markets that demand their services, and consumers to obtain protection for the purchase of goods and services that they wish to buy. They are government agencies that are involved in regulating trade and economic exchange, standards groups that seek to bridge the technology and profit interests between different producers, and user representation groups that seek lower-cost and higher-quality products and services. Examples are the World Wide Web Consortium (W3C), the Organization for the Advancement of Structured Information Standards (OASIS), Component Based Development and Integration (CBDI), and IT Infrastructure Library (ITIL). (See Text Box 1.)

These ideas are useful to identify where the innovations in the IT services management arena will cluster. With the technological innovations of IT services led by the innovator-producers, it is natural to think of the managerial responses that occur—the *first ripple*—as being a call for a new discipline of *service science, management, and engineering* (SSME). This will match the changed conditions in business processes, firms, and markets that are wrought by the services-oriented technological innovations [75, 121, 220, 221].

The IS and Computer Science Perspectives

The service science paradigm, from the perspective of the IS and computer science disciplines, involves all of the stakeholders. For example, the producer stakeholders have created and adopted the fundamentals of the service science paradigm to support efforts to commoditize their business processes, to make their technological architecture and infrastructure more effective, and to enhance operational efficiency and control costs. The services-oriented paradigm views the consumer stakeholders as co-developers and recipients of services. This paradigm has increased the attractiveness of market entry by value-added vendors, services process consultants, and assorted intermediary stakeholders. The new marketplace has transformed the relationships

Text Box 1. An Example: SaaS, ASPs, and CRM

A recent example of a technological disruption is the introduction of *software-as-a-service* (SaaS) and *application service providers* (ASPs) to the market for enterprise resource planning software. In the case of *customer relationship management* (CRM) software, a new stakeholder, SalesForce.com, entered successfully as a software and services innovator. This introduction rippled to the marketplace of buyers, where new clients, small and medium-sized businesses, were able to afford enterprise-quality software, only now delivered as a service. Fearing erosion of their markets, larger companies began to embrace SalesForce.com as well. Meanwhile, the existing innovators and producers, such as Siebel (now merged into Oracle), entered the marketplace with SaaS applications of their own. Since these applications are geared toward smaller firms, the existing providers relied on their existing sales channels, which changes the role of the *value-added reseller* as a business intermediary to one of a services delivery intermediary. Meanwhile, new standards have been evolving around the SaaS offerings, and new stakeholders are beginning to have an increasing say in how these standards will emerge.

these stakeholders engage in, far beyond the dyadic buyer–supplier relationships of the 1980s. Finally, there is increasing interest in the development and expansion of monitor stakeholders. Collectively, these stakeholders lobby for and provide technology standards and managerial guidelines on behalf of organizations that adopt the services-oriented paradigm.

SOA, Business Strategy, and IT Alignment

Spohrer et al. [222] define *services* as the application of competence and knowledge to create value between providers and receivers. This value accrues from the interactions of services systems that involves people, technology, organizations, and shared information in addition to language, laws, measures, and models. The goal of *service science* is to provide a foundation to advance our ability to design, refine, and scale services systems for practical business and societal purposes. In the IT context, services-oriented systems address the fusion of business processes and technologies by building innovative bridges or autonomous, implementation-independent interfaces from business processes to software, data, and technology services [152]. They also provide the capability to transform current technologies that exist in silos across the organization in support of flexible IT services. Linkages between business processes and services that source their execution will be aligned in a manner that facilitates cost advantages from the commoditization of hardware (e.g., on-demand utility computing, software-oriented infrastructure with virtualized resources, and infrastructure services providers), software (e.g., SaaS, SOA, and application service providers [ASPs]), and even business processes [62, 69]. This is referred to as a *service-oriented architecture* [30].[2]

SOA is not limited to Web services or architecture. It is about the value of distributed processes, reuse, information, and coordination. It offers benefits for enterprise connectivity by removing redundancies, generating collaboration tools, and streamlining processes [31, 72]. With services thinking, companies co-create their offerings with customers and break process silos into modular services that can be reused in loosely coupled services systems or out-tasked to external providers [73, 75]. *Out-tasking* occurs on a smaller scale than outsourcing. It involves individual tasks or parts of the process-sourcing strategy, not collections of them [144]. The services paradigm is still new and the technologies and practices are changing rapidly. Thus, it is time to rethink our managerial approaches to IS and technology from new organizational and technical vantage points [189].

One aspect of many IT services is the *high degree of involvement by people in delivery and usage.* The innovators, vendors and systems integration consultants, and consumers and users are critical. We recognize that innovation, planning, design, delivery, use, support, and maintenance of any IT service includes a variety of capabilities, heterogeneous expectations of value and performance, and the willingness to permit nonstandard solutions to co-exist with standard solutions [67, 99].

Another aspect of IT services is that they are *more or less intangible* [155]. IT services cannot be touched or felt, though they may be associated with something physical—a computer, a network server, or the activities of a business process. The installation of network cabling, including the physical production process of delivering the service through the cable, is tangible. Help desk operations, IT training, and systems design are not tangible. IT services cannot be stored in inventory for later use like commodity inputs or manufactured products. So the management of consumer demand and service delivery capacity supply will be similar to revenue yield management of perishable goods such as airline seats. Whatever services can be produced must be simultaneously consumed, a property called *inseparability.* Traditional measures of the quality of goods and organizational success are insufficient for effective management of intangible and perishable services.

Edvardsson et al. [84] noted that pricing decisions are crucial in services. They need to be value maximizing for production and consumption and, under some circumstances, must be provided in high volume with short response times. A related property is *co-creation by producers and customers,* which blurs the typical distinction between vendor and client [237]. IT services also involve *high customer–producer and vendor contact.* Krajewski and Ritzman [149] have argued that services providers sometimes may become customers in the delivery process, getting as much value from the process as they produce. This occurs in settings with co-production of software applications that are used as intended by the customer but subject to reuse and refinement by the producer.

We expect to see pressure on organizations with respect to technical, organizational, and behavioral challenges that must be overcome. Several perspectives from IS and computer science are useful for exploring research issues in IT services management. They include business strategy and IT alignment, the services-oriented property of *loose coupling,* use of semantics for interoperability, reuse and modularity as part of organizational culture, the organizational and human effects of SOA adoption, and organizational dynamic capabilities that are enabled by services-oriented technologies.

Mergers and acquisitions, new regulations, rapidly changing technology, increasing competition, and heightened customer expectations mean companies must become more responsive to changing demands in order to become more innovative and agile [52]. For organizations to respond to market changes promptly, their business strategies need to be tightly linked with their IT operations. Organizations need to sense and respond to market changes and reallocate their resources dynamically [175]. Today, some organizations still do not have the capabilities to react fast due to their IT infrastructures. Most enterprises do not have documented processes and policies in place [134]. Another challenge is inconsistent information scattered throughout the organization, which makes interorganizational and intraorganizational collaboration much harder. Internal and external regulations and compliance requirements also increase the environmental complexity of organizations [157].

This set of components can be defined in multiple ways. For example, Luftman and McLean [156] define *business strategy and IT alignment* in terms of the correspondence between the strategies, goals, and needs of the business and the requirements of IT-based systems. Alignment needs to be done for intra- and interorganizational processes [18], with a focus on external alignment with collaborators and business partners [167, 203].[3]

Characteristics of Systems and Organizations Implementing SOA

Loose Coupling

Loose coupling is a fundamental promise of services orientation properties to support organizational dynamism. With loose coupling, an organization maintains interdependent elements that vary in the number and strength of relationships with other elements in other locations. *Coupling* indicates these elements are linked. *Loose* means they are subject to spontaneous changes and possess some degree of independence [174]. So *loosely coupled system*s are connected yet changeable. Implementing an SOA allows loose coupling at multiple levels.

Service orientation allows loose coupling between an organization's application architecture and the business processes it supports [3]. Application logic can be decoupled within a system, just as business process logic is separate from business services, which are mapped to appropriate application services. This way, if business processes need to change to meet market changes, an organization only needs to alter its application service pattern to fit the new business logic. It will not need to develop a new application.

Dynamic Capabilities

Dynamic capabilities of an organization are vital to the development of greater process flexibility and agility in decision making [229]. Pavlou and El Sawy [184] explain how dynamic capabilities can be established with five major processes. The *integration process* supports implementation of new configurations of operational competencies by developing required patterns of systems interaction. The *coordination process* helps allocate resources and services, assign tasks, and synchronize activities. The *learning process* drives innovative thinking and new knowledge generation to enhance existing resources and services. The *sensing process* aids management's understanding of the environment, business needs, and opportunity identification. The *reconfiguration process* shapes existing resources and services into new configurations to match the environment.

The dynamic capability of a services environment implies that the system has long-term viability and that it meets services providers' objectives for scale, quality, production costs, margins, and return on investment (ROI). Similarly, infrastructure service dynamic capability involves IT, policies, organization, and coordination. Creating dynamic capabilities for the organization involves oversight, services and software, IT and infrastructure, scalability and scope, and performance assessment.

System Semantics and Ontology

The transformation to the services orientation involves the deployment of what is referred to as *semantics.* At the business process layer, semantics efforts represent the move toward standardization of business processes, operations, and information requirements, and their representations. These requirements can be turned into machine-processable descriptions by using semantic Web capabilities at the architectural services layer. A machine in a system will be able to execute these requirements with Web services through infrastructure resources to apply necessary functionality or complete a relevant task. Establishing appropriate *semantics* is a difficult task in a single organization, and it becomes almost impossible when many collaborating organizations in a value chain are considered.[4]

Central to all these efforts is the use of *ontology* to provide domain-based data representation to facilitate automated reasoning. One benefit is to provide a means for machine processing to dynamically bind disparate services together to deliver computational capabilities to an enterprise. Another is to use representations that make sense to humans. Because semantics requires achieving commonality and rigor with domain-specific phrases, words, and concepts, it makes sense that organizations devise their own semantics. They also need to pay attention to semantics development efforts that can link their business processes and computing capabilities to external communities.

Reuse, Modularity, and Decomposition

The services orientation for IT also has the potential to make out-tasking and outsourcing more effective because it reduces the dependencies between standardized units of services [153] and supports reuse. The commoditization of business processes, software services, and infrastructure requires strategies for reuse though. So discovering generic reuse processes that are relevant is important. Because business processes may share subprocesses, the ability to reuse subprocess capabilities is important. Another challenge of designing, executing, and maintaining an SOA is *services identification.* To identify reusable services that can be integrated, it is appropriate to have a methodology to support examination of the business from multiple perspectives and to identify the basic building blocks. Fundamentally, the services-oriented paradigm is a decomposition process that results in modularity [98]. This means that the logic required to solve complex problems can be broken down into smaller and more manageable components.

Modularity refers to the degree a system's components can be separated and recombined [14, 15, 212]. The basic premise is that modularity allows for greater agility when the need for change arises. Modular software or systems can be developed in the form of components with standardized interfaces. This permits parts of the software or the system to be easily changed with minimal interactions elsewhere and integrated into the whole system when there is a need.

Although there are exceptions [44], modular products typically lead to modular organizational forms [120], and are best produced by modular organizations [151]. This is consistent with the relationship between task environments and organization structure. The requirements of an organization's technological core shape the task environment, and this determines the appropriate organizational structure. However, there is a trade-off. As modularity increases, so does complexity. Baldwin and Clark [14] indicate that to be effective, modular systems require architectures that specify all modules and their functions, interfaces for module interaction, coordination, and communication, and the standards for testing the module's conformity to design rules.

Services-Oriented Technology Adoption and Management

Another issue with the adoption of services-oriented IT is how this process changes the way people and organizations work. *Coordination theory* provides a road map to investigate the process of managing dependencies between activities [162]. It identifies several such dependencies and describes the coordination processes between them. *Coordination structures* represent patterns of decision making and communication among a set of actors who perform tasks to achieve goals. There are four coordination structures—product and functional hierarchies, and centralized and decentralized markets. Each has trade-offs between production, coordination, and vulnerability costs.

Coordination costs in services systems arise due to the need to maintain communication links and exchange messages among the actors [71]. This includes formal knowledge and information sharing, task scheduling, transferring instructions for input and output, and other transaction costs. *Vulnerability costs* are incurred when sudden and unexpected changes arise. Relative to the different coordination structures that are possible for IT services, the consumer stakeholders are *task processor users.* Williamson's [234] *theory of transaction costs* concerning governance structures is another applicable theory for IT services that fits well. An organization's governance structure should be designed based on the degree of asset specificity and the complexity of its products' descriptions, which give rise to important considerations about the supporting role of IT services and related costs.

Based on its IT infrastructure for Web services, SOA offers new ways of viewing units of automation within the enterprise. It offers benefits such as "end-to-end enterprise connectivity by removing redundancies, generating unified collaboration tools, and streamlining IT processes" [30, p. 691]. The research has focused on technical prescriptions of best practices for architecture integration in various contexts [180].

Overall, there is little research on the organizational and human effects of SOA adoption, workflow patterns, knowledge sharing, and individual and group performance. Coordination and social network analysis will help to understand the human factors of SOA adoption. Coordination network analysis is based on prior research in network theory, and it looks at the formal coordination structures of human resources [106]. Social network analysis is more about informal relationships. Prior research has demonstrated that these networks of informal relationships influence workflows, knowledge sharing, learning, and innovation [42, 66].

Related Research Directions

Drawing upon the prior discussion, we propose the following research directions that seem appropriate for IS researchers to pursue, in collaboration with others from the appropriate disciplines:

> *Research Direction 1 (The Commoditization of Hardware, Software, and Business Processes): Research should focus on the effects of the commoditization of hardware (e.g., on-demand computing, cloud computing, SOA with virtualized resources, and infrastructure service providers), software (e.g., SaaS, and ASPs), and business process services.*

This research direction is a natural outgrowth of e-commerce, outsourcing, and process management, all of which are enabled by services-oriented technology and management. There has been limited research on the commoditization of processes and assessing the service quality risks associated with IT services outsourcing [69]. We call for research that supports organizational capabilities to propagate business process changes with minimal impact to underlying platform-specific architectures. More needs to be done related to handling dynamic business process workflow reliability and the mapping of reliable solutions to technology services [209].

> *Research Direction 2 (The Value and Agility of SOA-Based Enterprise Business Applications): Research should assess the agility aspects of SOA-based enterprise business applications, including customer relationship and performance management systems.*

Horizontal and vertical linkages between business processes and the application services that source their execution through related technology services also need to be aligned and streamlined.

> *Research Direction 3 (A Semantic Basis for SOA): We further call for development of a semantic basis for SOA, including the development of application domain*

ontologies, semantic Web technologies, and knowledge-based techniques for service discovery and selection.

Other related issues involve scalability, performance, and reliability of algorithms for processing transactions, queries, rules, and distributed events. Also important is research on enterprise application modeling and component integration, model-driven architecture and network, system, and application aspects that support trustworthy networked systems [230, 235].

The Economics of Information Systems Perspective

THE AUTHORS OF A 2006 ARTICLE IN Booz Allen Hamilton's *Strategy+Business* magazine, Couto and Divakaran [63] noted that after a series of high-profile failures occurred, many observers came to believe that outsourcing was on its way out. But early errors actually helped the industry evolve from one focused on cost to one focused on high-quality services critical to its customers. Today, outsourcing firms are upgrading their systems, offering increased flexibility, and focusing on performance and quality assurance. In spite of these concerns, the demand for and supply of IT services represent a burgeoning part of the global economy, and one whose innovations can be appropriated as value by organizations that adopt them. Paul Horn [121] of IBM's T.J. Watson Research Center has called for the development of a "new service science." Horn, recognizing that the U.S. economy is about 75 percent services today, views *service science* as "a melding of technology with an understanding of business processes and organization . . . crucial to the . . . next wave" [121]. The services orientation is an economic phenomenon of major proportions that requires the full attention of business leaders, company managers, innovators and intermediaries, educators, and government regulators to ensure that the value it offers comes to fruition [123].

Network Externalities, Standards, and the Development of Technology-Related Expectations

The new service science will benefit from leveraging long-standing ideas in economics that span network effects, as well as from technology and process standards formation as they relate to IT services and the services orientation. The network literature offers many insights regarding the effects of an installed base of technology [82, 89], market expectations about future network dominance [136], market uncertainty about standards and compatibility [88, 90], and path-dependent behavior of key services producers and services delivery intermediaries [109]. There is also knowledge about specific technologies and industries, including Federal Reserve bank check clearing [108], software provision [54], automated teller machines [204], Web servers [104], and telecommunications [83]. Much of this knowledge from economics can be ported to IT services contexts.

In the area of standards, the path to full technology adoption is often marked by events that help to diminish the uncertainty that exists in the market with respect to the technology and that individual potential adopters will feel by committing to particular kinds of solutions. Adopting an IT services orientation means that, in addition to make–buy decision making, a firm will have to simultaneously figure out who will be its vendors, how robust their solutions will be over time, what the value trajectory for technology will be, and whether it can expect to be locked in to the extent that future first-best IT infrastructure choices may not be reachable. Standards often arise from a number of different directions, and those are often difficult to foresee [136]. So managers at firms that are contemplating adoption of SOAs will need to consider the extent to which they are subject to *rational expectations–based decision making* [7, 8, 208].

The expectations of management decision makers are often based on the expectations of others with whom they associate—within their firm, in other competing firms, in other industries, and so on. They share information as a means to develop a dynamic consensus of what outcomes are likely to ensue in the marketplace. How do they do it? Prior research has shown there are at least three ways that information sharing may occur between different stakeholders that will assist their decision-making efforts [87]. Different forms of *economic institutions* are instrumental in moving information between consumers, firms, and managers. These include search markets for different goods and services and competitive markets that adjust prices for different levels of supply and demand. In addition, sometimes firms consciously communicate information to the marketplace about their intended actions or expectations [218, 219]. *Signaling* may occur as product preannouncements, statements of commitments to a standard, publication of services development path plans, and so on.

A third mode of communication is informal but effective in information transmission. *Cheap talk* is low-cost, nonbinding, and unverifiable communication between different stakeholders and sometimes reflects *strategic information transformation* on the part of the parties who share [65]. It happens a lot of different ways: e-mail, telephone conversations, coffee breaks at industry conferences, and discussions over meals. Kim [146] reports that although this type of communication may be easy to dismiss, people have an incentive to provide truthful information in such situations.

Decision makers are also subject to problems with strategic information transmission and information processing, which occurs with herd behavior in investments [16, 211], information cascades [32, 33], and market manipulation and credibility problems that are seen to occur in technology markets as well as financial markets [22]. This is critical for newly emerging technologies and technology-based business practices. These issues prompt us to recommend this body of theoretical knowledge in economics as a set of referents to understand the concerns of the producers and consumers. The choices vendors make on the direction and content of their innovations, and how they package them as products and services, will have a bearing on the compatibility and complementarities with existing standards. The literature offers an important body of theory relevant for the consumer stakeholders who need to decide whether to adopt these new technologies and services. It also has obvious implications for the formation of standards bandwagons.

The Business Value of Services-Oriented Systems

There are four trends that prompt action on the part of managers that relate to the business value of IT [215]. First, senior managers today seem to have a far greater appreciation of the game-theoretic aspects of their world, and they understand strategy in terms of the movement of markets from one equilibrium to another in the presence of technology changes. The move to a services paradigm requires an understanding of how changes in strategy and operational processes will change the demand for services systems components that have been designed as reusable business objects. So not only do the senior managers of companies have to worry about competitors in their business environment, they also need to consider how to increase their own flexibility and agility [205]. This is an important observation, because business value and firm performance are always determined in a "relative" way: relative to what competing firms are doing in the marketplace and how to achieve competitive advantage, potential value relative to the realized value a firm can obtain through technological agility and infrastructure flexibility, relative to the expanded range of strategy business choices that open up as a result of such dynamic capabilities, and so on.

Second, IT investment decision making is no longer a "seat-of-the-pants" process as it once was [19]. There are many approaches, but senior managers have not been able to agree on their usefulness in practice. It is all the more important that understanding of a services orientation carry over into IT investment practices, where ballpark estimates with strategic insight will be more useful than detailed quantitative evaluation without strong innovation and market transformation-based intuition.

Third, the practice of investing in IT has become a much more complex undertaking for senior managers. No longer is the choice "make versus buy." Instead, there are now many different levels of commitment that need to be thought through at the infrastructure, network, software development, application, data, and software object levels. The services orientation includes new developments in outsourcing, offshoring, utility and grid computing, service-level agreements, vendor-managed infrastructure, and Web services, as well as the economic risks they entail for the firms adopting them [49].

The economics of IT services motivates us to consider the possibility of a new valuation and ROI assessment paradigm. Management wonders how to achieve strategic alignment in cross-functional terms—by bringing together IS with operations, marketing, and supply chain management. The goals for IT and business alignment have moved beyond the traditional boundary of the firm. This creates an opportunity for a new *economics of services co-creation,* too [231]. The diffusion of these goals across distant geographies, into global markets for IT services, and onto the technology-based infrastructures of the IT services vendors is under way. Our stakeholder analysis suggests that the risks need to be controlled from all sides of the compass, most importantly by the buyers, intermediaries, and services creation innovators [6, 57].

The world is stochastic and unpredictable. Market competition, technological progress, and stakeholder interactions in services guarantee that the operating environment of large businesses will be complex. This makes it difficult to assemble and apply the appropriate tools to achieve effective organizational performance and technology investment [79]. As a result, organizations that adopt the service science paradigm need to build an awareness of how technology platforms [85, 91] and funding commitments for infrastructure [92] are affected by technological evolution. Kauffman and Li [137] have written about the "waiting game" for technology standards to take shape in a marketplace without government intervention and regulation, and how uncertainty causes a stochastic drift in valuation among the different stakeholders. Having stakeholders on the sidelines of the technology adoption decision processes creates undesirable pressure and uncertainty.

Changing Agency Relationships and Transaction Costs

One of the tenets of interorganizational interactions for supply chain management and procurement, provision of services, and joint investments in IT architectures is that the number of business partners is an economic decision. The literature is rich and helpful for explaining how the service paradigm is likely to affect the roles of the stakeholders. The expectation has been that technological progress has promoted a move from hierarchies as the dominant form of business organization to the market form. Many activities of the integrated firm of the past have been spun off, so the market can provide the best-quality, lowest-price products and services. This is the main thrust of the *electronic markets hypothesis* [163].

Others have argued that agency costs, information asymmetries, and strategic behavior on the part of key stakeholders add another layer of complexity that mutes the effects of IT. Clemons et al. [61], with their *move-to-the-middle theory,* have articulated the fullest statement of this perspective. Relational risks, vendor opportunism, and other forms of agency costs diminish a buyer's incentives to have transactions with too many suppliers. The inherent complexity of many relationships—even though they may be mediated by IT infrastructures and services that are highly effective—makes it hard to overcome the downside risk in loss of value when problems occur.[5] Kauffman and Mohtadi [138] propose a risk-augmented transaction cost perspective and explain what happens in proprietary and open supply procurement platform adoption when there is uncertainty about demand and supply.

Related Research Directions

We propose two research directions that pertain to the economic perspective on service science:

> *Research Direction 4 (The Business and Economic Value of Service Science): Research should target the study of the business and economic value of service science in the organization and market context in which they are most relevant.*

The opportunities for research will come with the study of how IT-based changes how the service infrastructures of modern organizations are architected and how the development of tailored services derive the greatest value from them. On the IT services side, we expect tensions to mount between the long-standing move-to-the-middle perspective of Clemons et al. [61] and the newer justifications for IT services procurement with even fewer suppliers [141]. On the marketing services side, we expect to see the emergence of reusable marketing services components. These plug-and-play components will cover service and product pricing capabilities, advertising-related decision support, product design knowledge components in targeted areas, and other new developments. Similar opportunities to study IT services value will come as cloud computing emerges. We suggest:

Research Direction 5 (The Effects of Cloud Computing): Additional service science research should be done to explore the value of cloud computing in specific industry settings.

Kay defines *cloud computing* as

> a system where users can connect to a vast network of computing resources, data and servers that reside somewhere "out there," usually on the Internet, rather than on a local machine or a LAN or in a data center. [It] can give on-demand access to supercomputer-level power, even from a thin client or mobile device such as a smart phone or laptop. [143, p. 1]

Chappell [46] defines a *cloud computing platform* as one that lets developers write applications that run in cloud computing environments or uses services that are provided by such an environment, or both. Some pre–cloud computing platforms have been referred to as *on-demand platforms* and *platforms-as-a-service.* They incorporate the capabilities of SaaS application execution and delivery as well as *attached services.* An example of an attached service is iTunes, which is used locally on a personal computer, which permits music acquisitions from the marketplace that Apple offers via its service functionality to support search and purchase. A related opportunity for service science research involves the circumstances under which companies will choose to form their own value-producing *private cloud computing networks,* which is similar to the idea of that was floated earlier in the 2000s about a "private Internet" for large corporations [43]. This brings up the general issue of the industrial structure of the players that will populate the market for cloud computing services, how the stakeholders will interact, and how their roles may shift.

Research Direction 6 (Agency Relationships and Changing Industry Structure): Research should be undertaken to explore the changing nature of agency relationships around IT services as well as the changing nature of industry structure.

Service science can be conducted at a higher level of analysis as a means to predict changing vendor–client relationships in the marketplace and industry structure. Some other contexts involve the global distribution systems of the travel and hospitality industry [109] and the value chain in the digital music distribution market [37]. Another example is Microsoft, which recently became a late entrant to the Internet-based IT services market with what it calls "Azure" (www.microsoft.com/windowsazure/

windowsazure). It is staying with the familiar Microsoft operating system, server, and application products, but its stated goal is to have firms and consumers access them in new ways via a *proprietary cloud computing network.* Microsoft hopes to gain share in a growth marketplace for computing services [119]. There will be significant interest in conducting service science research on how cloud computing affects agency relationships in specific industry contexts, where the extent of economic value produced should be unique. One context is health care, for things such as pharmaceutical research and test-based diagnosis. Others include government intelligence, aircraft design, weather forecasting, and financial services. The high-speed networks associated with this technological innovation will make the new capabilities possible [194].[6]

The Finance Perspective

Much of the application of financial economic theory and methods takes place along the producer and consumer stakeholders' axis in Figure 1, with additional involvement from intermediaries and value-added packagers of IT services. The production of IT services occurs externally to the firms that use them as well as internally. In this sense, the producer and consumer stakeholders may be different parts of the same organization, instead of two or more different organizations.

Negotiation, Contracts, Valuation, and Execution

Negotiations in the services domain involve complex interactions between the producers of technological innovations and the associated partners, intermediaries, clients, and users. These interactions may involve discussions regarding opaque cost structures, incomplete markets, and transfers of risk between parties. All IT services, even those that are automated, are subject to negotiation for the terms and the conditions of their offering, followed by an execution phase [78]. During the execution phase, the parties are subject to a variety of risks from opportunistic behavior [6] or technical, market, or competitive risks associated with the delivery of the IT solution [23]. Clients and providers can leverage information regarding this risk exposure during negotiations. Although previous work has addressed risk management from the transaction cost and agency theory perspectives [6], current perspectives on risk management draw upon financial economics [19]. These include real options theory [79], risk management thinking such as "black swan" extreme value theory [226], value-at-risk [130] and contingent claims theory [24], and auction-based approaches to model volatility in IT services delivery [113].

Clemons and Gu [57] and Dos Santos [80] were among the first to recognize that IT investment management should be viewed as a process that offers valuable managerial flexibility, with the timing of investment or with its delay. The manager, as a consumer stakeholder, holds an option to abandon or delay a project [79]. Benaroch [23] provides an overview of the typical options seen in IT investments. The strategic and operational flexibility inherent in IT service relationships is constrained by the client–vendor contract. A client cannot abandon a project that an IT services vendor has contracted to deliver without exercising a buyout or backsourcing clause. And a provider, as a direct producer of the service or as an intermediary in the delivery of the IT service, cannot scale back delivery unless the client agrees or it is otherwise specified in the contract. Techniques to value real options can be leveraged by these three kinds of stakeholders to inform contract negotiation and the timing of contractual options, such as abandonment or backsourcing [24]. For much of the execution phase, however, firms may need to consider other techniques to actively manage risk.

Financial Risk Management for IT Services

Financial risk management theory considers three sources of risk—operational risk, credit risk, and market risk [25, 130]. We draw an analogy involving these three sources of risk for the new financial economics–based perspectives to the financial management of IT services.[7] First, we consider *operational risks in IT services* as delivery or project-specific risks that arise with IT, organizations, and business processes. These risks occur on the provider side—whether a producer or an intermediary—such as missing a service-level target due to lack of available technology or operational problems. Operational risks may also occur, such as with respect to network or communications failures that disrupt IT services delivery. We think in terms of *client demand risk in IT services.* Bhargava and Sundarasen [28, 29] remind us that demand uncertainty on the client side is one of the paramount risk considerations in an IT services contract. A benefit of IT services is that clients can have flexible "on-demand" access to an IT infrastructure without the uncertainty of making large-scale investments. Finally, we consider *market risk of IT services* as the uncertainties with the underlying technology and labor markets. These uncertainties could be associated with various forces, including standards [137], labor markets [24], and revenues and costs volatility [80].

The operational risks associated with IT services delivery also fit the IT investment perspective. Benaroch [23] views these as *firm-specific risks* in the context of IT investments. Dos Santos [80] modeled integrated services digital network (ISDN) adoption and implementation cost risks in an options model and showed that follow-on investments should be modeled and understood by the manager. Taudes et al. [228] studied the adoption of the enterprise resource planning (ERP) systems and found that firms can leverage flexibility of timing such investments in the face of adoption and effective use of software platforms.

Schwartz and Zozaya-Gorostiza [214] modeled costs by considering risks specific to the firm's implementation of a technology, as well as market risks associated with acquiring technology inputs. In the context of IT services, a provider firm may be able to stage a rollout of service delivery. Kauffman and Sougstad [139] proposed an approach involving value-at-risk methods to evaluate trade-offs that occur when a provider delivers a service through dedicated, on-site resources versus pooled resources shared across contracts. This enables the provider to limit its exposure to operational risk for any single client. Tansey and Stroulia [227] proposed a contingent valuation perspective for SOA design. They assessed how option value works for the potential reuse of different components, modules, and services. Applications of financial management techniques to IT services have centered on client demand risk, from the viewpoint of the consumer stakeholders in our framework. Bardhan et al. [17] modeled a portfolio of IT investment opportunities subject to client adoption risk. They showed that option valuation could shed light on how to optimally sequence IT project investment decisions that had various operational and strategic interdependence.

Researchers have used other methods to manage client demand uncertainty. Paleologo [179] proposed a model for pricing grid services using a value-at-risk model. He analyzed how firms can make significant improvements over cost-based pricing by incorporating risk considerations. Hackenbroch and Henneberger [115] also utilized a value-at-risk model to value grid infrastructures in financial services firms. They focused on the inherent demand variability of the usage of computing resources in financial services, which tend to fluctuate greatly during peak trading and transaction-making periods. Other researchers have modeled demand variability for pricing. For example, Kenyon [145] analyzed demand variability as a natural basis for pricing variable-capacity outsourcing contracts.

We define *market risks in IT services* as those associated with standards, technology evolution, competition, and labor markets, as we noted earlier. Benaroch et al. [25] assessed environmental and technological risks in an empirical validation of options analysis for IT investments. Kauffman and Li [137] modeled platform adoption decisions and found that optimal timing decisions are affected by the ability of the firms to apply rational expectations and wait until a standards winner emerges. Gaynor and Bradner [105] also developed an options-based model for the market adoption of IT network standards. Although the perspective of financial management of market risks is somewhat less well developed outside of real option methods, significant opportunities exist to exploit uncertainties in service life cycles, as well as in the context of declining costs of IT services [70]. In this vein, Kauffman and Sougstad [140] discussed the potential application of risk management methods to capture the effects of labor cost uncertainties associated with delivering IT services involving vendors that have a portfolio of customers.

Related Research Directions

State-of-the-art applications of financial economics–based techniques for IT services management are still nascent. Nevertheless, we expect to see great strides made in the "financification" of IT services management due to the clarity that financial economics has to offer for decision making. We propose:

> *Research Direction 7 (The Service Science Relationship and Productivity Metrics and Pricing and Contract Specification Approaches): It will be important to develop metrics, models, and methods that provide support for managerial decision making regarding IT services issues, especially IT services pricing, contract design, and shared organizational investment.*

> *Research Direction 8 (The Financification of IT Services): We encourage scholars and practitioners to undertake new research to explore the extent to which financial economics approaches, such as portfolio management, risk management, and extreme value analysis, will be useful for active management of IT services risk for the producer and consumer stakeholders.*

These research directions build on the prior discussion of financial economics and risk management approaches to IT services management [24, 140, 179]. We believe consumers, producers, and intermediaries will benefit from viewing services networks as portfolios of relationships with complex and interdependent obligations and benefits [139]. Services producers can leverage economies of scale, scope, and risk diversification by applying a portfolio view. Intermediaries can play a role in providing transparency for IT services through pricing research and other consulting services they offer. Likewise, clients can leverage supply-side economies of scale through their portfolio of services spending. Our projection of the importance of this research stems from what we see in the economics of IS more generally. There is increasing interest in the areas of ownership and joint investment theories, contract economics, bundling [13], and the underlying rationale for information sharing and service component sharing. Beneficial methods developments involving financial economics for service science will emerge in support of infrastructure and SOA evaluation approaches, too.

The Marketing Perspective

The evolution of the service science paradigm from the perspective of the marketing discipline can be better understood when we trace the developments in thinking, theories, and frameworks in the services marketing literature that have emerged in the recent past. The theories central to the marketing discipline—social exchange theory, transactions cost theory, and consumer choice theory—reinforce the view of the transactional, exchange-based, goods-dominated model of marketing. However, recent developments in services marketing have emerged with the disruptive effects of Internet technologies. This encourages researchers to broaden their horizons and rescope their work so that it encompasses all of the key stakeholders—producers, consumers, intermediaries, and monitors. Such a broadening of scope is a necessary condition for the beneficial evolution of the service science paradigm and the theory of service-dominant logic [34, 200].

There are several implications as a result of this emergent thinking. First, the ideas provide a different "lens" to view the findings of past research in services marketing. Second, they offer important frameworks to understand the interface issues between marketing and other disciplines. Finally, they lay the foundation for the emerging service science mind-set that is critical for cross-disciplinary research. We will delineate new issues from services marketing that contribute to service science thinking—the e-services orientation, the theory of service-dominant logic, personalization and customization, customer relationships, and customer equity—based on the social exchange viewpoint of relationships.

Services Marketing

Even prior to the Internet technology–driven disruption, the focus of services marketing had always been on the consumer stakeholders shown in Figure 1—customers, clients, and users—especially understanding their needs and creating benefits to meet them. There was an interest in defining service quality and designing service delivery from the customers' viewpoint, thereby assisting the producer stakeholders to compete effectively in the market by providing value to customers. Topics such as service quality, managing customer expectations, customer satisfaction, customer loyalty, services design and service-scapes, services pricing, service encounters, service recovery, self-service technologies, and customer co-production of services have dominated the field for the past 25 years [34]. These have evolved from the theoretical viewpoint of purely examining transaction costs to the more contemporary viewpoint of social exchange and relationships.

The Internet and the emergence of the network-based economy have only made the focus on customers more important. Technologies such as wireless, broadband, data warehousing, data mining, and agent technologies are contributing to the accessibility and servicing of targeted segments of customers for businesses and governments while providing more choices and options to customers. This has had the effect of shifting power to the customers. These technologies have also enabled businesses to improve their service processes, develop new markets, and improve their competitive positions. They also are enabling the transformation of physical products to pure service components, especially the network-based, digital, and information-based products [133]. This leads to a blurring of the distinction between products and services, a boundary that for a long time has defined the scope of services research. In addition, the shifting of market power to the consumer stakeholders, the rapid commoditization of products brought about by IT, and the trend toward businesses migrating up the value chain to services as their primary value generators all are hastening the transformation of the world economy from a goods-based to a services-based economy [199]. These developments have also led to more expansive thinking in the realm of services marketing.

The E-Services Orientation

The immediate effect of this expansion has been in the online environment, where it evolved into an *e-services orientation* [199]. This is a coherent point of view that challenges many of the traditional assumptions about how to increase revenues in the online environment. The approach is based less on reducing costs through automation and IT to achieve service efficiency and more on expanding revenues through enhanced services and building profitable customer relationships. Thus, IT should help firms to be both forward focused and outward looking, emphasizing the need to understand the customer more, and complementing the present-focused, inward-looking view of technology-based services systems and efficiency.[8]

Enabling strategies and tactics to make value equity a reality calls for the development of a technology infrastructure to support them. This technology infrastructure can be developed at the firm level by firms interested in providing customer value, or by a network of firms interested in benefiting themselves in the supply chain as well as their customers, or at the market level by government entities. Investment in Internet technologies and broadband to create such networks is a good example. The analysis of ROI in such a technology infrastructure and deployment calls for objective measures of the benefits—whether service quality, value equity, personalization and customization, customer satisfaction, or customer loyalty. Development in the area of services metrics and customer equity management [201] can lead to quantification of such benefits that are necessary to support business decisions for the investment in such technology and its subsequent successful deployment.

Service-Dominant Logic: A Theory for Service Science in Marketing

One of the most important paradigm shifts in thinking about services that emerged around the same time as the e-services orientation has significantly altered the scope of services research in the marketing domain. The new *service-dominant logic* proposed by Vargo and Lusch [231] can be viewed as emerging out of the natural evolution that has been enabled by the series of technological disruptions in the last two decades of the twentieth century. This evolution started with a fundamental shift in the definition of *services.* The traditional view of services is often a restricted conceptualization. It treats services as a residual, especially something that is offered to enhance the goods or products via value-added services, or in terms of situations that are devoid of readily defined products; for example, think of *services industries,* including health care, government, and education. Instead, Vargo and Lusch treat services as the application of specialized competencies—for example, knowledge and skill—through acts, processes, and performances to create value for the benefit of another entity or the entity itself. Moving away from the goods and product-centered view where people mostly exchange goods, service-dominant logic contends that people engage in exchange to get the benefits of specialized competencies, knowledge, and skills as *operant resources.*

Products or goods are subsumed in value creation for services. Goods are transmitters of operant resources—that is, they are *embedded knowledge.* They also are intermediate products used by other operant resources as *appliances* in value-creation processes. This implies that customers are co-producers of services, and they themselves become operant resources. Thus, the value of any exchange or relationship is perceived and determined by customers on the basis of *value-in-use.* Value results from the beneficial application of operant resources that are sometimes transmitted through other operant resources. Firms can only offer compelling value propositions, but they actually have to be actualized or brought to life in a business process context by customers [231].

One of the important implications of the service-dominant logic is that because value is perceived and determined by the customer, the producer stakeholders need to be customer-centric—something they have long espoused in words but have not had the technological capabilities to implement in a truly effective way. They need to learn the value they are creating for their customers. Services systems design, pricing, and innovations all emerge from this customer-centric focus. They center on enhancing the value that is created for the customer and lead to increased revenue rather than improved internal efficiency alone [160]. The emergence of this paradigm has spawned new efforts to understand the dynamics of services systems that can bring value to the service science perspective [158].

The evolution of service-dominant logic has contributed in a significant way to theory development in marketing. Heretofore, *goods-dominated logic* was a guiding (if limited) theory for marketing. The *marketing mix approach* arising out of goods-dominated logic was geared toward purchasing. It did not include consumption as an integral part of marketing theory. During the process of consumption, value is generated for consumers and the relationships that organizations build with them. The focus in services marketing, then, is not on goods but on *interactions in services encounters.* Service-dominant logic gives an important theoretical base for analyzing marketing problems this way. It provides a foundation to understand customer relationships, a key shift characterizing the process of marketing to the customer.

Personalization and Customization, Customer Relationships, and Customer Equity

IT-based systems allow firms to target customers through new channels, such as e-mail, short message services (SMS), Web sites, and targeted databases, adding to their revenue streams. Customer portals and online services kiosks provide new ways of disseminating information to customers, which in turn allow firms to develop closer relationships with their customers by increasing the frequency and precision of marketing messages while obtaining richer insights into customer behavior and customer loyalty.

Personalization and customization efforts are the natural outcome of a customer-centric approach facilitated by IT. If the customers' value-in-use is measured by a firm to determine what value customers derive from services, then the by-product of such measurement will be the determination of an individual customer's preferences and willingness to pay. This can further lead to customized services offerings and pricing [5, 110, 127]. Focused, relevant offerings reduce overall costs for customers—via lower search cost, lower risk costs, and lower transaction costs—and build in switching costs. They also reduce the costs of providing services for the firms as customer preferences become accurately known, better predicted, and more fully met. The effect is the same across a variety of services settings—B2B, business-to-consumer (B2C), and government-to-consumer (G2C) commerce are all included.

The challenges that customization will face in the service-dominant paradigm are many. The traditional product-centric view calls for quality in products through standardization, and customization has always been viewed as mass customization that will not affect the quality negatively. Customization in the traditional service context, meanwhile, has been viewed as individualized services design and services delivery, and there have been problems scaling up such efforts.

The topic of customer satisfaction and relationships has been widely studied in the services marketing literature, encompassing issues such as customer satisfaction and delight [39, 40, 173, 182], customer expectations [172], customer satisfaction measurement and analysis [95, 96, 129], and customer loyalty and retention [38, 193]. Most of this research has been in the context of individual services providers interacting with their customers. However, given the increasingly global nature of services provision through offshoring and outsourcing, services networks that involve components of services from multiple providers are becoming very common [198]. In addition, because some services are co-produced by customers, how then should customer satisfaction be measured in such contexts? How will this kind of customer involvement relate to loyalty? What does a *customer relationship* mean in the context of services networks? Who will "own" these kinds of relationships, and how should the quality of services be measured and guaranteed in such contexts?

A recent development in marketing is the measurement of the *value of a customer* and how to link the customer to firm profitability and firm value. *Customer lifetime value models* originated in the direct marketing context [27, 81]. They soon were extended to other contexts and used to guide marketing investments and corporate strategy. The concepts of one-on-one marketing, database marketing, and customer relationship management (CRM) all emerged in the early to mid-1990s. These techniques used the power of customer databases and data warehousing technology to analyze customers and treat them as a "portfolio" that needs to be actively managed to extract the greatest value for the organization (e.g., [36, 191, 192, 201, 202]). *Customer equity* is the sum of all customers' lifetime value, and it has been linked to financial performance [114]. The successful implementation of the customer life cycle valuation model, and CRM concepts, and also using them to guide strategy requires a customer-centric focus that permeates the organization—and not just the marketing or sales or services part of the organization. Despite the initial enthusiasm, though, such implementations have not paid off consistently in different industry settings, to our knowledge. With the service science paradigm and its power to link various disciplines, better insights should be obtainable to understand how the power of IT artifacts such as CRM can be harnessed.

Service Management and Linkages with Other Disciplines

Let us consider some of the links. Service management research has focused on issues ranging from services demand (e.g., [20, 41, 210]) and services pricing [68, 216] to guarantees for services delivery [166, 177] and employee incentives [116]. Given the nature of services, many of these issues cut across services operations and organizational behavior. With the e-services orientation and the service-dominant logic perspective, the locus of these problems will be more on customers than on business processes or organizational units. For example, services demand management and services pricing call for a better understanding of how customers derive value from a firm's core value propositions, and how much of the services that are offered are co-produced. Thus, management and modeling approaches to services demand problems need not assume that demand is fixed. Instead, the idea is to actively manage demand through self-service and co-production. Similarly, customer-centric service pricing can be very flexible, based on management's understanding of how customers derive value. This should lead to better yield management techniques and methodologies. In addition, because goods can be viewed as intermediate products through which operant resources are exchanged with customers, and customers can be viewed as operant resources, demand management and pricing can become very flexible—services can be inventoried if needed and pricing can be personalized. The notion of services guarantees and employee incentives can be closely related to customer value, too.

A natural outcome of the expansion in the scope of services is that issues at the interface of the other disciplines with marketing become much more critical. The nature of services is highly interdisciplinary. Researchers within each discipline are good at providing solutions for which the controls and the outcomes typically lie within their own discipline's scope. But when controls or outcomes are outside that scope, it becomes important to understand the linkages and the nature of the trade-offs. Consider the satisfaction and productivity trade-off for services [4]. The customization of services may call for individualized services design and delivery, whereas efficient production may call for more process standardization and less variability. These objectives are at odds with each other. Increasing the revenue of the firm demands a customized customer-centric approach, based on the e-service orientation and service-dominant logic; but operational efficiency and cost-effectiveness may call for just the opposite.

Such trade-offs abound in the services context. Services designs generally focus on reducing variability in operations and increasing efficiency, whereas services delivery may demand robustness to different variance drivers that are encountered in practice. Similarly, at the interface of human resources and services marketing, there are issues with regard to whether a satisfied employee is a necessary condition for a satisfied customer. While some research has taken it as an entering premise [131], others have questioned such links [213]. Similarly, the issue of variability in employee performance in interacting with customers has attracted attention. So it is clear that expanding the scope of services can lead to the development of new paradigms that will be more effective.

An example of where a service science paradigm may help is in services systems designs when engineering and IT together interact with services operations and marketing teams [132]. In services systems, variability is encountered in many components, interfaces, and entities interacting with the system. There could be variations in services system performance across different usage situations and conditions. It is in this context that a service science paradigm is needed. It will provide not only a new perspective for the research that is ongoing in a particular discipline but also a framework to link up with other services disciplines so as to coordinate work on problems that occur at the interface. Such work has been going on sporadically—the linkages between service operations and service marketing is a good example—but more is needed. Some developments such as CRM may never deliver the expected payoffs, if an integrated view of services across all the functions of a firm never emerges. These observations call for critical work in contributing toward a service science mind-set that spans the marketing and IS disciplines, emphasizing the service orientation.

Related Research Directions

We propose a number of research directions that tie in closely with the analysis of the issues and the literature that we have offered the reader from the marketing perspective. An interesting avenue for research that the service science paradigm may be able to contribute to is how to mass customize service design and delivery. Although personalization and customization of services in the online context have been achieved mainly in the context of e-retailing and are well researched (e.g., [5]), mass-customized services in other channels and in other contexts lag behind. Thus, we propose:

Research Direction 9 (The Design of Mass Customized Systems): We encourage joint marketing and IS research efforts to explore the ways that service science approaches can be developed to make the design of mass customized systems in marketing more effective.

We have observed the role that customers play in the construction of services in the presence of advanced IT and the importance of firm awareness of the opportunities to engage them in service co-creation. The current state of our knowledge is not far enough advanced to make this the kind of service science that we envision being possible, however. Thus, we propose:

Research Direction 10 (Knowledge of Value-Maximizing Customer Involvement in the Co-Creation of Services): As physical and social networks of customers are facilitated by emergent technologies, new research needs to focus on service designs that support the co-creation of services with firms that are able to consistently produce value-maximizing service process design.

The service-dominant logic clearly identifies customers as operant resources capable of creating customized services for their needs. Social networks, based on Web 2.0 and other technologies, provide the infrastructure allowing firms to reach stakeholders in all quadrants to interact and network in ways hitherto impossible. This network of firms and customers, intermediaries and customers, and customers who are in touch with other customers provides significant potential to create value [198]. How can services be designed to take advantage of such opportunities while ensuring high levels of service quality, personalization and customization, and customer satisfaction? We call for collaboration among IS researchers and their counterparts in marketing, consumer psychology, and service operations research to harness the potential value of social networks for co-creation of services. (For our additional thoughts on this broad-brush recommendation, see Text Box 2.)

The Operations and Supply Chain Management Perspective

The operations and supply chain management discipline has the potential to play a marquee role as a basis for an emerging science of services in concert with the IS discipline. The former discipline has offered foundational definitions for key concepts and constructs, and it continues to provide useful guidance for the management of services operations. Sampson differentiates the *services operations management* discipline from traditional production and operations management:

> in service processes, the customer provides significant inputs into the production process. On the other hand, within manufacturing processes, while groups

Text Box 2. The Services-as-Art Perspective on Service Science for Marketing and IS Research

The aesthetic aspect of service creation and delivery provides another stream of inquiry that will shape research in e-services. Fisk et al. [93] propose a *services-as-theatre* perspective, in which services are viewed as *performances,* involving *actors* who transmit meaning and information to *customer audiences.* For example, the act of hiring is considered to be a process of casting *service actors.* Later work draws on principles derived from the training of actors, such as Stanislavsky's methods, to guide the management of *service interactions* [112]. Further work extends the *services-as-art perspective* to draw upon a metaphor of playing jazz music [128]. Service firms must coordinate complex activities and must often utilize *improvisation* when dealing with stakeholders.

In the e-services perspective, the theatre becomes virtual but the performance is no less important to the customer. Design skills from the gaming industry may play an important part as companies present services in a virtual world. This can be seen with IBM, Hewlett-Packard, and other firms offering not only a presence, but real services, such as customer support, information, and recruiting services, in Second Life. Current technologies allow customers, as the audience, to participate in the services performance. Web 2.0 social networking sites permit customers to add content and comments and experience the delivery of the service. An example is Wesabe (www.wesabe.com), an online personal finance site in which members participate as a community, rating various businesses and providing financial tips to other members. Another is RateBeer (www.ratebeer.com), which specializes in craft brewing, and NetFlix's Pandora (www.pandora.com), which supports customer co-creation of Internet radio streaming music, based on individual tastes and listening histories.

> of customers may contribute to product design, individual customers' only participation is to select and consume the output. [206, p. 16]

Several characteristics of services processes make them unique when compared to traditional production processes [147]. They include:

- *Heterogeneity:* Individual units of services production are unique, which can be primarily attributed to the heterogeneity in customer inputs [207].
- *Simultaneity:* Services are produced and consumed simultaneously, which differs from traditional processes where products are created in advance of demand and consumption [164].
- *Perishability:* A services provider's capacity to produce services is time-sensitive because significant elements of the production cannot happen before customer inputs are present [164].
- *Customer co-production:* Customers participate in the production of services by providing not only labor but also property and information that assist the process [207].

IT is a critical determinant of the design of services processes and the quality of services delivery [154, 188]. It has special relevance for the producer, intermediary, and consumer stakeholders and can serve multiple roles in the services delivery process. For example, many firms employ self-service technologies to increase the effectiveness of technology-mediated communication channels with customers. *Self-service technologies* are IT-enabled interfaces that facilitate sales and related transactions, such as customer ordering, payment, and exchange without human intervention [165]. Because interpersonal interactions are more expensive than automated transactions, self-service technologies have led to a dramatic reduction in transaction costs through the elimination of face-to-face interactions, thus lowering employee and customer support costs.

Services in Operations Management and Supply Chain Management

Spohrer and Maglio note that "a central problem in service science is . . . understanding service system evolution" [220, p. 243]. Services innovations can be fostered in different ways, including improving *customer relevance,* the degree to which operational processes are able to sense and meet customer needs. *Customer agility* is the ability to engage customers in the exploration of innovation opportunities [205]. This type of competence involves customers in new product ideation as users in testing and filtering ideas and the enhancement of virtual communities for product design and testing [168]. Sambamurthy et al. [205] describe the case of eBay, which uses its customers as product development teams by gleaning insights based on their feedback obtained through Web portals. CRM systems similarly enable managers to identify customer requirements in a timely manner and facilitate customer participation in project decisions. Individual-level communication tools, such as instant messaging, permit project teams to solicit customer and supplier input for key project decisions. These can lead to improvements in the quality of such decisions.

Services innovation can also be fostered by improving the services processes that enable project teams to leverage their firm's physical and knowledge assets and the competencies of suppliers, distributors, and partners in the exploration of new opportunities [205]. Technologies such as collaboration portals, supply chain management systems, and knowledge management software enable project teams to leverage knowledge assets across the firm, quickly identify qualified suppliers, and coordinate information flows [18]. New types of Web 2.0 technologies, such as the corporate use of Twitter and social networking tools, also can improve customer relevance by improving the productivity of service interactions and service productivity.

Spohrer and Maglio [220] proposed a research framework for studying work evolution in service systems. They posited that work systems evolve over time from fully human systems involving interpersonal collaboration (face-to-face customer service) to fully automated (face-to-screen customer service) systems with little or no human contact (see Table 1).

They describe a service system in which developers and engineers *collaborate* without direct technological support for customer services (row 1, column 3). As demand for the service and the need for greater scalability increase, however, it is not possible to provide the same quality of service that technological support can by using human customer service support alone. In such environments, firms typically *augment or enhance* their human services processes with some level of automation (row 2, column 3). A simple approach is through the use of a frequently asked questions (FAQ) tool [222].

Table 1. A Framework for Customer Contact in Technology-Enabled Services Settings

Type of service interaction	Type of contact	Technological enablement for customer contact	Level of collaboration	Level of human involvement	Examples
Face-to-face customer service	Collaborate	Technology free	High	High	Interacting with a service representative in a face-to-face customer service episode without any technology support.
	Augment/ enhance	Technology assisted	High	Medium	Using an FAQ tool in a face-to-face consultation with a human customer service representative of a company.
		Technology facilitated	High	Low	Using a screen-based video tool to resolve a problem or get an answer to some issue that requires company assistance.
Face-to-screen customer service	Delegate	Technology mediated	Low	High	Using an instant messenger tool or e-mail to interact with a third-party service representative for a company.
	Automate	Technology generated	Low	Low	Using the Internet to purchase an airline ticket without interacting with a service representative.

Note: Adapted from frameworks attributable to Froehle and Roth [101] and Spohrer and Maglio [220].

As demand for customer services increases, firms may seek to outsource via owned or third-party services providers in India, Eastern Europe, the Philippines, and elsewhere to produce the customer support component of their services processes. The same is true for other business processes, such as new product development, market research, and business process outsourcing services. The next step is to *delegate* outsourced services processes to other service providers (row 3, column 3). These typically are in-house-affiliated service providers or third-party vendors. With recent technological advances and Web 2.0 technologies, the final step that organizations take is to *automate* services processes (row 4, column 3). They may do this themselves, but we increasingly see such services purchased externally by the firm. An example is automated speech recognition systems. These now can provide self-service support to customers. In such automated services environments, customer *self-service technologies* lower employee and customer support costs through the implementation of IT-enabled interfaces that facilitate sales and related transactions. These include customer ordering, payment, and exchange [165].

Spohrer and Maglio [220] provide useful thoughts for discussion of work evolution in service science, especially from an operations and supply chain perspective. The types of information-intensive services depicted in Table 1 can be supported by one or more forms of customer contact that involve a combination of human and IT-enabled processes.

The Modes of Technology-Mediated Customer Contact in Services

Froehle and Roth [101] have proposed a conceptual typology of a *technology-mediated customer contact model* that differentiates between physical face-to-face and virtual screen-to-face contact in services operations. Froehle and Roth's typology of technology-mediated customer contact is also shown in Table 1. Froehle and Roth's typology involves three types of *face-to-face customer contact*—technology free, technology assisted, and technology facilitated. The authors also define two types of *face-to-screen customer contact*—technology mediated and technology generated. In the *technology-free customer contact mode,* the customer interacts with the service representative independent of technology. Such contacts are typical of some types of services work that involve sales and product demonstrations and analysis-intensive services that require face-to-face collaboration, such as legal or accounting services.

In the *technology-assisted customer contact* mode, the customer interacts with a service representative who, in turn, relies on an IT infrastructure to service the customer. Such interactions may be in the form of a CRM system that the service representative accesses to obtain appropriate information during the service process. With *technology-facilitated customer contact,* in contrast, both the customer and a service representative may access a Web portal to obtain access to a service. However, the customer and service representative still communicate independently of the technology that is available [197]. Information-intensive services in the technology-assisted or technology-facilitated customer contact modes are representative of IT tool–augmented service work, where technology assists in the delivery of services but may require some human intervention from service representatives at a call center.

In the *face-to-screen customer contact mode,* the IT platform mediates communication between a customer and service representative. Such technologies involve online e-commerce Web sites where information flows between the service representative and the customer are channeled through the technology of a digital intermediary, such as via an online live chat feature. The last type of contact, the *technology-generated customer contact,* is representative of situations where the customer is self-serviced primarily through a technology platform or layer, such as with travel reservations or scheduling systems. Services work that entails technology-mediated customer contact is more likely to be outsourced to third-party vendors or offshored to captive customer service centers to achieve lower labor costs. On the other hand, services that involve technology-generated customer contact are more likely to be fully automated through a self-service e-commerce platform that is integrated with speech recognition software.

The service representative typically represents the producers, who include the innovators, developers, and direct-delivery providers of the service production process. The customers are the consumers, and may be users or clients. In some instances, the service representatives may be more like intermediaries though. This group is composed of business partners, systems integrators, value-added resellers, and systems solutions brokers. In such cases, the customer may interact with these intermediaries in their service encounters due to expertise that the intermediaries bring. In both cases, the IT involved may be a tool that is jointly or separately developed by the producer and intermediary but is available to either party to service the customer. The monitors may represent government, industry, and user standards organizations that also stand to benefit through interactions.

In many knowledge-intensive industries, services managers are focused on providing personalized services offerings that require high-touch or high-tech delivery processes. Such differentiation becomes important in the context of professional services, where knowledge workers are more likely to provide services based on the face-to-face model [103]. Customer service is more likely to be provided through face-to-screen contact. For example, high-end consulting services that involve rigorous analyses (e.g., management consulting or architectural services) require face-to-face contact, whereas business process outsourcing is likely to involve services delivered via face-to-screen modes. The design issues and integrating challenges associated with such customized service processes have not been fully examined, and they have not been conceptualized as critical to services strategy [197].

The Current State of Services Research in Operations Management

E-services delivered through electronic channels are becoming an increasingly important area for research in operations management and IS [117, 197]. Many of the traditional notions of services management and its economic value have not been empirically validated in electronic markets. To date, research in IS and operations and supply chain management has been mostly *customer based,* focusing on the online experience [170], services quality [239], and customer choices [126]. They also have been *operations based,* with a focus on customer efficiency [236] and customer services process configurations [117, 196]. Roth and Menor observe that "neither knowledge-based e-service paradigms nor core operating principles related to e-service strategies have been rigorously examined" [197, p. 159]. Similarly, the areas of B2B e-commerce and people-to-people services, such as the online interest-specific communities eBay, Facebook, or MySpace.com, have gained increasing importance, but research from a services management perspective has lagged behind.

An area that has received scant attention is system dynamics and its application to services research. *System dynamics* is a method to depict, model, and simulate dynamic systems [111]. It provides a useful framework to study information flows from a service science viewpoint. Characteristics associated with real-world operations management problems, such as feedback loops, accumulation processes, and delays, are sometimes ignored in analytical and empirical research. System dynamics offers an alternative lens to study, explain, and interpret such phenomena in operations and supply chain management. Forrester [97] developed a system dynamics–based simulation of a supply chain consisting of four stages—factory, warehouse, distributor, and retailer. Forrester's model describes the dynamic flow of goods and orders in industrial systems and shows that inventories in the different stages are amplified when moving down the supply chain. Hence, system dynamics provides a structural framework to explain how delayed information and material flows, when combined with feedback loops, result in oscillations in system behavior. This is commonly referred to as the *bullwhip effect.*

System dynamics models are more descriptive than normative. They focus on investigating a system with its complexity, instead of deriving elegant, optimal solutions. Grobler et al. [111, p. 379] categorized the literature on system dynamics into papers dealing with production flow and supply chain management, process improvement programs in operations, project management issues, new product development and innovation, and effects of different production technologies. For services research, Oliva and Sterman [171] examine services systems in which increases in services demand allow for a number of alternate provider responses, such as increasing effort, cutting corners, and investment in greater capacity. System dynamics enable us to understand services issues involving optimal investment strategies for managing talent, technology, and environments in services delivery.

Related Research Directions

The trend toward globalization of supply chains has created a need to develop a better understanding of services system evolution [222]. We propose the following research direction:

> *Research Direction 11 (The Specialization of Modularization and Services): Research should be undertaken to understanding the changes in business processes*

associated with greater modularization of services for effective global operations and supply chain management.

Innovations in services creation and delivery have been accompanied by greater specialization of services, wherein customers and producers often co-create value. This affects business process design. For the producers, specialization can lead to greater talent, high technology, and superior capabilities for creating value-added services [220]. Such work system evolution is also associated with a greater need for *trust* and *coordination* across the extended network of stakeholders—producers, intermediaries, value-added sellers, consumers, governmental standards organizations, and developers. Understanding the system dynamics of services systems provides opportunities to develop models that capture the essence of service operations [171]. It is critical to understand when transitions can occur between various states in the evolution of services systems—from fully human systems to technology-augmented systems to outsourced systems across firm boundaries and fully automated, self-service systems. Both analytical and simulation approaches to solve these problems are required, but so too are experimental and behavioral approaches. Thus, we propose:

Research Direction 12 (Experimental and Behavioral Research Approaches): There is high potential for new knowledge from the application of experimental and behavioral science methods to build service science approaches in operations and supply chain management settings.

Services systems are essentially sociotechnical systems that are a collection of interdependent entities. It is important to apply new techniques grounded in behavioral theories of operations to address a number of questions. How does the nature of customer contacts change as firms move to more "high-touch" experiential customer service environments? What are the linkages between customer service design and outcomes related to emotional responses, such as customer satisfaction? What trade-offs exist between the use of high-experience services versus traditional approaches to customer service? Experimental economics-based approaches can also provide a useful setting to empirically study these issues and develop a better understanding of specific conditions and situations that are more suitable for experiential services. Knowledge-based e-services, such as the types of services provided through business process outsourcing, fall into this category. Froehle and Roth [102] and Voss et al. [233] provide useful ideas for research in services operations involving customer behavior. Also important will be

Research Direction 13 (Cloud Computing Service Design Issues in Operations and Supply Chain Management): There are major opportunities for new research to probe the extent to which cloud computing service design decisions are able to best support operations and supply chain management and the value co-creation activities of their primary stakeholders.

The emerging services-oriented technology approach that pushes Davenport's commoditization of IT the farthest is cloud computing [118]. Baker [12] characterizes the emergence of cloud computing as a technological transformation in the power of computing that brings to mind the transition that the industrial economies of Europe and North America made to electricity in the late 1800s and early 1990s, which eliminated the need for individual businesses to use their own generators in lieu of acquiring power from utilities.[9]

In spite of this positive view of the future for cloud computing, there are those who believe this development will not bring high business value to the vendors that offer services this way in the near term, or to the clients that sign on to use it. For example, Knorr and Gruman [148] view it as being in the early stages of the hype cycle, and refer to it as "sky computing." They note that the primary components include single-applications SaaS through browsers, utility computing and server infrastructure virtualization, Web services via the Internet to support the market for service-focused software objects, service computing systems development platforms, managed service providers, service commerce platforms and service hubs acting as automated cloud computing service bureaus, and Internet integration for connections among SaaS providers. Clearly, there are many issues related to cloud computing that need to be sorted out by IS researchers.[10]

More generally, there is a critical need to empirically measure the productivity of service innovations within service-oriented systems. In industrial work, the productivity effect of technology has been viewed as simply increasing the output and decreasing the inputs needed for processing. In an innovation-oriented context, though, the quality of the work and the outcome may be equally important, if not more salient, than the quantity of output produced. Thus, we propose:

> *Research Direction 14 (Productivity and Service-Oriented Systems Performance): There is an important opportunity to redefine our approaches to the assessment of productivity and the operational performance of services-oriented systems through the development of new conceptual and modeling approaches.*

Extending a manufacturing mind-set to the application of IT in services may be counterproductive for services-oriented systems. Application of IT in knowledge-intensive services settings, such as the small-scale "skunkworks" of research and development and innovation for operations management, requires adaptation and additional sensitivity to the unique characteristics of these environments. It is important to remember that IT's primary benefits in the area of services processes are twofold. First, IT helps in the achievement of consistent results and supports the organization in creating better-quality outputs through improved market intelligence and customer-focused business intelligence. Third-party customer information from online discussion media enables the firm to leverage its work with global suppliers and to reuse knowledge assets from other organizational entities as well [18]. Second, IT-enabled service processes help a firm to keep its customers engaged throughout their relationship, whether in joint project contexts, for procurement and supply chain management, or for after-sale customer service. IT does this at a lower cost and with higher quality than would ever be possible for relationship managers to achieve otherwise. As a result, the research agenda for IS and operations management relative to service science is very rich.

Conclusion

Contributions

This paper presented a robust analysis framework that we used to evaluate the existing literature, the current emphases in research, and the likely outcomes and directions that we expect to see in the short and medium term with respect to services-oriented technology and management and to service science. In addition to its focus on the effects of technological disruption, the framework emphasizes the multiple roles of different stakeholders: producer stakeholders, including service innovators and producers; consumer stakeholders, including customers, users, and buyers; intermediary stakeholders, including value-adding sellers, consultants, and system integrators; and, finally, monitor stakeholders, comprising standard organizations, vendor consortia, and user groups. No stakeholder group is any more important than another; however, the locations of the producer and consumer stakeholders and the intermediary and monitor stakeholders are intended to highlight their opposing interests and their shared concerns. Our framework also points to the nature of the primary, secondary, and other effects of the technological changes that are under way and shows where different theories and methodologies are likely to find an important place in the foundational knowledge of the emerging discipline of service science.

Aspirations for an integrated services culture are now pervasive in the management philosophies of modern organizations. A unique contribution of this paper is its perspective on services-oriented technology in multidisciplinary terms, including IS, computer science, economics, finance, marketing, and operations and supply chain management. The result is comprehensive coverage and interpretation of the issues and theoretical perspectives that will be useful for those who wish to identify starting points for their own research and applications to better understand services-oriented innovations. Because the study of service science as a fundamental content area for IS research has only started up recently, many of the research streams that we discussed are still in the preliminary stages. We will see it mature rapidly in the IS and computer science disciplines. The marketing and operations and supply chain management disciplines are further along in their handling of services, while economics and finance researchers are only beginning to catch on to the importance of doing this kind of research.

Limitations and Future Work

There are additional and important *behavioral and organizational issues* that we have not fully addressed. For example, what will be the effects of service orientation and technology on knowledge management in organizations? How will career paths and the required skills sets be changed? What can be done to pave the way for harmony between technological innovation and skilled labor development? Future work should further explore the theoretical perspectives and approaches that will yield new knowledge about the efficacy and effects of SOA and services management.

Second, we have not given the producer stakeholder issues as much scrutiny as might be appropriate in view of their key role as innovators. The impetus for technological innovation, the capability to produce technology infrastructures and services, and knowledge of what the market is ready to embrace fall into the producer stakeholders' domain. Much of the critical data regarding services design, economics, and organizational effects will be in the hands of the services vendors and their intermediaries and the value-added vendors. This presents opportunities for collaboration between industry and academics. Vendor firms may realize benefits from sharing data and third-party services cost benchmarking among their industry alliance partners and even their competitors. With the rich spectrum of issues, we recognize that the intermediary stakeholders—as value-added services providers adapt to ease the changes that organizations will experience—deserve their own research agenda.

Third, the importance of the customer-centric view in the IT, marketing, and operations and supply chain management contexts is plain. To achieve value from this perspective, it will be necessary for firms to consider how their business processes should be adjusted, their organizational units de-siloed, and their management's thinking retooled to go beyond the existing focus on the organization and operation of business units and business functions. In effect, we are arguing here—counter to the current catechism of the IS discipline—that business processes are a necessary, but not a sufficient, emphasis. Instead, it will be necessary to jointly emphasize the strategies that heighten the relevance of the design of business processes, the roles of the customers they serve, the innovative uses of technology that are possible, and the economic and financial outcomes associated with conducting business in this manner.

A final caveat that we offer comes with our recognition of the extent to which leading industry players are driving technological developments and management practices with respect to IT services and SOAs. Firm such as IBM, Intel, Unisys, Oracle, and other very large players all have a huge vested interest in the success of the services-oriented paradigm, as do the host of other smaller producer and intermediary stakeholders that are a part of the industrial structure of this arena. Our primary observation is that what comes out in the years to come—the *future history of service science*—is likely to be strongly dependent on the multiple paths of the large innovator-producers, much as we saw with mechanical typewriters and computer keyboards in the twentieth century and personal computers, handheld computing devices, digital wireless phones, and digital cameras more recently.

Acknowledgments: The authors thank the following people for helpful comments and interactions: Michel Benaroch, Jian Chen, Qizhi Dai, Mike Goul, Ting Li, Fu-Ren Lin, Paul Maglio, Yong-Jick Lee, Arti Mann, Jim Spohrer, Raghu Santanam, Sagnika Sen, Ben Shao, Juliana Tsai, Eric van Heck, Jamshid Vayghan, Peter Vervest, and Vladimir Zwass. Rob Kauffman also acknowledges the W.P. Carey Chair at Arizona State University; the Shidler School of Business, University of Hawaii; the Rotterdam School of Management, Erasmus University; the School of Economics and Management, Tsinghua University; National Taiwan University of Science and Technology; and the National Science Council of Taiwan for generous funding. The usual disclaimers apply.

Notes

1. Service science is grounded in the cross-functional issues of business and its operating processes. Its theoretical roots extend to engineering, technology, and the social sciences. Related theories illustrate this. For example, the *theory of transformation* [150] has been stated in terms of value deficiencies, work processes, decision making, and social networks. Another, *sociotechnical systems theory* [10], is used to represent and understand self-regulation for interactions between physical and institutional structures. *Services complexity theory* [122], which typically is expressed as a function of the number and variety of people, technologies, and organizations linked in value-creation networks, is noteworthy. *Theories of consumer behavior* are also relevant, including customer decision making, role experience, customer satisfaction, and perceived quality.

2. In contrast, Erl defines *service-oriented architecture* (SOA) as "a technical architecture, a business modeling concept, a piece of infrastructure, an integration source, and a new way of viewing units of automation within the enterprise" [86, p. 476]. Another definition, from OASIS, suggests it is a "paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects" [190, p. 6].

3. Organizations have challenges with this important task. Technological convergence and the services orientation will enable organizations to transform their traditional silos and tightly coupled business processes that support business strategies into more loosely coupled services and align them vertically with IT services that are sourced by virtual resources. Establishing services-oriented business and architecture is also key to establishing loosely coupled services and integrated value chains [240].

Services-oriented organizations have three layers that support business strategy execution, ranging from top-level business and business processes (e.g., business service choreographies and ITIL), to the mid-level architectural layer with services (e.g., SaaS), to the infrastructure layer (e.g., utility computing, SOA with virtualized resources) [181]. These services are similar to reusable objects (e.g., components, modules) that represent repeatable business activities and tasks and should be accessible through a network that enables intra- and interorganizational value networks [185]. The goal is to facilitate acquisition and integration of the best business and technology services that can be obtained from the market with maximum agility.

4. Meta-modeling has been proposed to enable Web services execution. A *meta-modeling language* involves syntax, semantics, and notation to express information, knowledge, or systems constructs in a structure defined by rules.

5. Clemons's research articles on transformations involving economic exchange in markets and organizations in the past 20 years point to a number of sources of these problems. They include the functionality risk of business IT [55] and the lack of corporate understanding of the need for in-depth strategic analysis of IT investment decision making [60]. He also points to the changing economics of coordination of business processes and ownership of shared IT infrastructures [59], a theme that has been echoed by others [162]. He further notes specific agency issues involving buyers and sellers, including poaching and information exploitation [58] and the necessity of bonding seller performance in e-markets where trust is lacking [56].

6. The vision for the future of internal risk management IT that is represented by cloud computing is a medium- to long-term opportunity for banks, brokerage houses, and insurers, but the conceptual ideas behind the development of the virtualization layer between applications and distributed computing resources are being worked out [76]. Major players in global financial services (especially Singapore and Hong Kong) have already embraced the idea of grid computing so that IT services demand spikes can be handled as market purchases. They also view the economic performance and the nearly unlimited processing power to be attractive [21]. More recently, the European Union–funded CATNETS (the catallaxy paradigm of market adjustments that bring order via the decentralized operation of dynamic application networks) project has been exploring the creation of a self-organizing financial market for grid services similar to how electricity grid markets work [224]. As a result, there is ample opportunity to bring mechanism design, an important branch of economics, into the context of service science.

7. *Operational risk* consists of issues that could arise that disrupt the ability of the financial institution to carry out its duties. IT failure and security breaches are both operational risk considerations. *Credit risk* refers to the likelihood of a borrower defaulting on interest or principal payments. *Market risk* refers to economic conditions that affect the volatility of the prices of traded assets or derivatives.

8. Parasuraman et al. [183] define *service quality* for the new services environment. At a *strategic level,* the e-services orientation calls for moving the emphasis from products and transactions to services and relationships. It advocates viewing customers for their equity value to the firm. At a *tactical level,* the e-services orientation calls for personalization and customization, self-service strategies, privacy and security management, and value co-creation.

9. Baker goes on to illustrate the idea of cloud computing in the context of Google, which now provides many of us with cloud computing–based e-mail through its Gmail service. He asks:

> What is Google's cloud? It's a network made of hundreds of thousands, or by some estimates one million cheap servers, each not much more powerful than the PCs we have in our homes. It stores staggering amounts of data, including numerous copies of the World Wide Web. This makes search faster, helping ferret out answers to billions of queries in a fraction of a second. Unlike many traditional supercomputers, Google's system never ages. When its individual pieces die, usually after about three years, engineers pluck them out and replace them with new, faster boxes. This means "the cloud" regenerates as it grows, almost like a living thing. [12]

Recognizing additional new opportunities with the expansion of IT services and services-oriented computing, IBM [124] spent about $1.6 billion on data centers globally in 2008, including a cloud computing infrastructure and its "Blue Cloud" approach. IBM has referred to this as *autonomic computing* to indicate the capabilities of adaptive systems that are self-managing and widely distributed. An important thrust of its current strategy is to create capabilities in the arena of *cloud computing services management.* In 2007 and 2008, it announced the opening of cloud computing centers in Africa and China [194]. IBM's shift to cloud computing service management has been prompted by the global growth in collaborative business, future trends in connected computing and personal digital devices, greater intensity of the use of real-time data and video streams, and other Web 2.0 and social networking capabilities.

10. Ricciutti has quoted Richard Stallman of open source computing renown as saying: "We've redefined cloud computing to include everything that we already do. [It] forces people to hand over control of their information to a third party. It's just as bad as using a proprietary program" [195]. Stallman characterizes cloud computing as a "marketing hype campaign" and expresses concerns about vendor lock-in and escalating user costs, in the presence of escalating vendor market power. In addition, Larry Ellison, the chairman of Oracle Corporation, has indicated that he believes that cloud computing will not be profitable for the vendors due to its complexity [119]. Too many more innovations are required to flesh a fully workable approach that provides not only the massive joint application-and-computing hardware connectivity that is envisioned. Many other observers view on-demand computing services as already having peaked, though this is not the dominant view that is expressed in the marketplace now. Foley [94], meanwhile, suggests that other significant issues need to be overcome, such as the management of security and customer data privacy, the extent of client control of data and applications, services delivery across hybrid computing environments, and the development of standards for cloud computing services interoperability.

References

1. Adomavicius, G.; Bockstedt, J.; Gupta, A.; and Kauffman, R.J. Making sense of technology trends in the information systems landscape: A design science approach. *MIS Quarterly, 32,* 4 (December 2008), 779–809.

2. Adomavicius, G.; Bockstedt, J.; Gupta, A.; and Kauffman, R.J. Understanding evolution in technology ecosystems. *Communications of the ACM, 52,* 10 (2008), 117–122.

3. Allen, P.; Higgins, S.; McRaie, P.; and Schlaman, H. *Service Orientation: Winning Strategy and Best Practices.* New York: Cambridge University Press, 2006.

4. Anderson, E.W.; Fornell, C.; and Rust, R.T. Consumer satisfaction, productivity, and profitability: Differences between goods and services. *Marketing Science, 16,* 2 (Spring 1997), 129–145.

5. Ansari, A., and Mela, C.F. E-customization. *Journal of Marketing Research, 40,* 1 (May 2003), 131–145.

6. Aron, R.; Clemons, E.K.; and Reddi, S. Just right outsourcing: Understanding and managing risk. *Journal of Management Information Systems, 22,* 2 (Fall 2005), 35–56.

7. Au, Y., and Kauffman, R.J. What do you know? Rational expectations and information technology investment. *Journal of Management Information Systems, 20,* 2 (Fall 2003), 49–76.

8. Au, Y., and Kauffman, R.J. Rational expectations, optimal control and information technology adoption. *Information Systems and E-Business Management, 3,* 1 (March 2005), 47–70.

9. Au, Y., and Kauffman, R.J. The economics of mobile payments: Understanding stakeholder issues for an emerging financial technology application. *Electronic Commerce Research and Applications, 7,* 1 (Spring 2008), 141–164.

10. Avgerou, C.; Ciborra, C.; and Land, F.F. (eds.). *The Social Study of Information and Communications Technology: Innovation, Actors and Context.* Oxford: Oxford University Press, 2004.

11. Babaie, E.; Hale, K.; Souza, R.D.; Adachi, Y.; and Ng, F. Forecast: IT services, worldwide, 2003–2010. Gartner, Stamford, CT, November 30, 2006.

12. Baker, S. Google and the wisdom of clouds. *BusinessWeek* (December 13, 2007) (available at www.businessweek.com/magazine/content/07_52/b4064048925836.htm).

13. Bakos, J.Y., and Brynjolfsson, E. Bundling information goods: Pricing, profits, and efficiency. *Management Science, 45,* 12 (December 1999), 1613–1630.

14. Baldwin, C.Y., and Clark, K.B. Managing in an age of modularity. *Harvard Business Review, 75,* 5 (May 1997), 84–93.

15. Baldwin, C.Y., and Clark, K.B. *Design Rules, Volume 1: The Power of Modularity.* Cambridge: MIT Press, 2000.

16. Banerjee, A. A simple model of herd behavior. *Quarterly Journal of Economics, 107,* 3 (August 1992), 797–817.

17. Bardhan, I.; Kauffman, R.J.; and Naranpanawe, S. IT project portfolio optimization: A risk management approach to software development governance. *IBM R&D Journal,* 2010, in press.

18. Bardhan, I.; Krishan, V.; and Lin, S. Project performance and the enabling role of information technology: An exploratory study on the role of alignment. *Manufacturing Services and Operations Management, 9,* 4 (Fall 2007), 575–595.

19. Bardhan, I.; Sougstad, R.; and Bagchi, S. Prioritization of a portfolio of information technology projects. *Journal of Management Information Systems, 21,* 2 (Fall 2004), 33–60.

20. Basuroy, S.; Chatterjee, S.; and Ravid, S.A. How critical are critical reviews? The box office effects of film critics, star power and budgets. *Journal of Marketing, 67,* 4 (October 2003), 103–117.

21. Beck, R. Benefits of service grids and cloud computing for the financial services industry. Workshop paper, Special Interest Group on Service Science, Paris, France, 2008.

22. Benabou, R., and Laroque, G. Using privileged information to manipulate markets: Insiders, gurus and credibility. *Quarterly Journal of Economics, 107,* 3 (August 1992), 921–958.

23. Benaroch, M. Managing IT risk: A real options perspective. *Journal of Management Information Systems, 19,* 2 (Fall 2002), 43–84.

24. Benaroch, M.; Dai, Q.; and Kauffman, R.J. Should we go our own way? Backsourcing flexibility in IT services contracts. *Journal of Management Information Systems, 26,* 4 (Spring 2010), 317–358, this issue.

25. Benaroch, M.; Lichtenstein, Y.; and Robinson, K. Real options in IT risk management: An empirical validation of risk–option relationships. *MIS Quarterly, 30,* 2 (June 2006), 827–864.

26. Benyoucef, M., and Rinderle, S. Modeling e-negotiation processes for a service-oriented architecture. *Group Decision and Negotiation, 15,* 5 (October 2006), 449–467.

27. Berger, P., and Bechwati, N. The allocation of promotion budget to maximize customer equity. *Omega, 29,* 1 (February 2001), 49–61.

28. Bhargava, H.K., and Sundaresan, S. Contingency pricing for information goods and services under industry-wide performance standards. *Journal of Management Information Systems, 20,* 2 (Fall 2003), 113–136.

29. Bhargava, H.K., and Sundaresan, S. Computing as utility: Managing availability, commitment, and pricing through contingent bid auctions. *Journal of Management Information Systems, 21,* 2 (Fall 2004), 201–227.

30. Bieberstein, N.; Bose, S.; Walker, L.; and Lynch, A. Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals. *IBM Systems Journal, 44,* 4 (2005), 691–708.

31. Bieberstein, N.; Bose, S.; Fiammante, M.; Jones, K.; and Shah, R. *Service-Oriented Architecture Compass: Business Value, Planning, and Enterprise Roadmap.* Upper Saddle River, NJ: FT Press, 2005.

32. Bikhchandani, S.; Hirshleifer, D.; and Welch, I. Learning from the behavior of others: Conformity, fads and informational cascades. *Journal of Economic Perspectives, 12,* 3 (Summer 1988), 151–170.

33. Bikhchandani, S.; Hirshleifer, D.; and Welch, I. A theory of fads, fashion, custom and cultural change as informational cascades. *Journal of Political Economy, 100,* 5 (October 1992), 992–1026.

34. Bitner, M.J., and Brown, S.W. The evolution and discovery of service science in business schools. *Communications of the ACM, 49,* 7 (July 2006), 73–78.

35. Blackhurst, J.; Wu, T.; and O'Grady, P. Network-based approach to modeling uncertainty in a supply chain. *International Journal of Production Research, 42,* 8 (April 2004), 1639–1658.

36. Blattberg, R., and Deighton, J. Interactive marketing: Exploiting the age of addressability. *Sloan Management Review, 33,* 1 (Fall 1991), 5–14.

37. Bockstedt, J.; Kauffman, R.J.; and Riggins, F.J. The move to artist-led music distribution: Explaining market structure changes in the digital music market. *International Journal of Electronic Commerce, 10,* 3 (Spring 2006), 7–38.

38. Bolton, R.N. A model of perceived service value. Paper presented at the American Marketing Association Educators' Conference, San Francisco, August 1988.

39. Bolton, R.N., and Drew, J.H. A longitudinal analysis of the impact of service changes on customer attitudes. *Journal of Marketing, 55,* 1 (January 1991), 1–10.

40. Bolton, R.N., and Drew, J.H. A multi-stage model of customers' assessments of service quality and value. *Journal of Consumer Research, 17,* 4 (March 1991), 375–384.

41. Bolton, R.N., and Lemon, K.N. A dynamic model of customers' usage of services: Usage as an antecedent and consequence of satisfaction. *Journal of Marketing Research, 36,* 2 (May 1999), 171–186.

42. Brass, D.J.; Galaskiewicz, J.; Greve, H.R.; and Tsai, W. Taking stock of networks and organizations: A multilevel perspective. *Academy of Management Journal, 47,* 6 (December 2004), 795–817.

43. Brodkin, J. Private cloud computing networks are the future of corporate IT. *Network World* (November 12, 2008) (available at www.networkworld.com/news/2008/111208-private-cloud-networks.html).

44. Brusoni, S., and Prencipe, A. Making design rules: A multi-domain perspective. *Organization Science, 17,* 2 (March 2006), 179–189.

45. Cases, P. Software as a service: The offerings are ready. *Optimize, 56* (June 2006) (available at www.informationweek.com/news/showArticle.jhtml?articleID=188702385&queryText=leaded).

46. Chappell, D. A short introduction to cloud platforms. David Chappell and Associates, San Francisco, CA, August 2008 (available at www.davidchappell.com/CloudPlatforms--Chappell.pdf).

47. Chesbrough, H., and Spohrer, J. A research manifesto for service science. *Communications of the ACM, 49,* 7 (July 2006), 35–40.

48. Cheung, W.K.; Zhang, X.F.; Wong, H.F.; Liu, J.; Luo, Z.W.; and Tong, F.C.H. Service-oriented distributed data mining. *IEEE Internet Computer, 10,* 4 (July–August 2006), 44–54.

49. Choudhary, V. Software as a service: Implications for investment in software development. In R.H. Sprague (ed.), *Proceedings of the 40th Hawaii International Conference on System Sciences.* Los Alamitos: IEEE Computer Society Press, 2007 (available at www.computer.org/plugins/dl/pdf/proceedings/hicss/2007/2755/00/27550209a.pdf?template=1&loginState=1&userData=anonymous-IP%253A%253A71.99.94.194).

50. Christensen, C.M. *The Innovator's Dilemma.* Boston: Harvard Business School Press, 1997.

51. Christensen, C.M., and Raynor, M.E. *The Innovator's Solution.* Boston: Harvard Business School Press, 2003.

52. Christensen, C.M., and Raynor, M.E. *How to Avoid Commoditization.* Boston: Harvard Business School Press, 2008.

53. Chu, S.C. From component-based to service-oriented software architecture for healthcare. In H.K. Choi (ed.), *Proceedings of the 7th International Workshop on Enterprise Networking and Computing in Healthcare Industry.* Los Alamitos, CA: IEEE Computer Society Press, 2005, pp. 96–100.

54. Church, J., and Gandal, N. Network effects, software provision and standardization. *Journal of Industrial Economics, 40,* 1 (March 1992), 85–104.

55. Clemons, E.K. Investments in information technology. *Communications of the ACM, 34,* 1 (January 1991), 22–36.

56. Clemons, E.K. An empirical investigation of third-party seller rating systems in e-commerce: The case of buySAFE. *Journal of Management Information Systems, 24,* 2 (Fall 2007), 43–71.

57. Clemons, E.K., and Gu, B. Justifying contingent information technology investments: Balancing the need for speed of action with certainty before action. *Journal of Management Information Systems, 20,* 2 (Fall 2003), 17–42.

58. Clemons, E.K., and Hitt, L. Poaching and the misappropriation of information: Transaction risks of information exchange. *Journal of Management Information Systems, 21,* 2 (Fall 2004), 87–107.

59. Clemons, E.K., and Row, M.C. Information technology and industrial cooperation: The changing economics of coordination and ownership. *Journal of Management Information Systems, 9,* 2 (Fall 1992), 9–28.

60. Clemons, E.K., and Weber, B. Strategic IT investments: Guidelines for decision-making. *Journal of Management Information Systems, 7,* 2 (Fall 1991), 9–28.

61. Clemons, E.K.; Reddi, S.P.; and Row, M.C. The impact of IT on the organization of economic activity: The "move to the middle" hypothesis. *Journal of Management Information Systems, 10,* 2 (Fall 1993), 9–35.

62. Click, R.L., and Duening, T.N. *Business Process Outsourcing: The Competitive Advantage.* New York: John Wiley, 2004.

63. Couto, V., and Divakaran, A. How to be an outsourcing virtuoso. *Strategy+Business, 44* (Autumn 2006), 1–11.

64. Cox, D.E., and Kreger, H. Management of the service-oriented architecture life cycle. *IBM Systems Journal, 44,* 4 (2005), 709–726.

65. Crawford, V., and Sobel, J. Strategic information transmission. *Econometrica, 50,* 6 (November 1982), 1431–1452.

66. Cummings, J.N. Work groups, structural diversity, and knowledge sharing in a global organization. *Management Science, 50,* 3 (March 2004), 352–364.

67. Danaher, P.J. Customer heterogeneity in service management. *Journal of Services Research, 1,* 2 (August 1998), 129–139.

68. Danaher, P.J. Optimal pricing of subscription services: Analysis of a market experiment. *Marketing Science, 21,* 2 (Spring 2002), 119–138.

69. Davenport, T.H. The coming commoditization of processes. *Harvard Business Review, 83,* 6 (June 2005), 100–108.

70. Demirhan, D.; Jacob, V.S.; and Raghunathan, S. Strategic IT investments: The impact of switching cost and declining IT cost. *Management Science, 53,* 2 (February 2007), 208–226.

71. Demirkan, H. Supply chain management of application service providers: Coordination strategies and queuing effects. *Journal of Business, 78,* 1 (January 2004), 209–232.

72. Demirkan, H., and Goul, M. Towards the service-oriented enterprise vision: Bridging industry and academics. *Communications of the AIS, 18,* 26 (2006), 546–556.

73. Demirkan, H., and Goul, M. Process and services fusion impact assessment: SSME findings from industry collaboration and the need for competency centers. In B. Hefley and W. Murphy (eds.), *Service Science, Management and Engineering: Education for the 21st Century.* New York: Springer, 2008, pp. 257–262.

74. Demirkan, H.; Soper, D.; and Goul, M. Service-level agreement negotiation: A theory-based exploratory study as a starting point for identifying negotiation support system require-

ments. In R.H. Sprague (ed.), *Proceedings of the 38th Hawaii International Conference on System Sciences.* Los Alamitos, CA: IEEE Computer Society Press, 2005 (available at www.computer.org/plugins/dl/pdf/proceedings/hicss/2005/2268/01/22680037b.pdf?template=1&loginState=1&userData=anonymous-IP%253A%253A71.99.94.194).

75. Demirkan, H.; Kauffman, R.J.; Vayghan, J.; Fill, H.G.; Karagiannis, D.; and Maglio, P.P. Service-oriented technology and management: Perspectives on research and practice for the coming decade. *Electronic Commerce Research and Applications, 7,* 4 (Fall 2008), 356–376.

76. Derivix launches cloud-based risk management. Press Release, Derivix, Chicago, November 10, 2008 (available at www.derivix.com/press.php?href=company_press_release_nov).

77. De Souza, V., and Cardozo, E. A service-oriented architecture for deploying and managing network services. In B. Benatallah, F. Casati, and P. Traverso (eds.), *Service-Oriented Computing—ICSOC 2005, Lecture Notes in Computer Science,* vol. 3826, Berlin: Springer, 2005, pp. 465–477.

78. Dietrich, B.; Paleologo, G.A.; and Wynter, L. Revenue management in business services. *Production and Operations Management,* 17, 4 (July–August 2008), 475–480.

79. Dixit, A., and Pindyck, R. *Investment Under Uncertainty.* Princeton: Princeton University Press, 1994.

80. Dos Santos, B. Justifying investments in new information technologies. *Journal of Management Information Systems, 7,* 4 (Spring 1991), 71–90.

81. Dwyer, F.R. Customer lifetime valuation to support marketing decision making. *Journal of Direct Marketing, 3,* 4 (Fall 1989), 8–15

82. Economides, N. The economics of networks. *International Journal of Industrial Organization, 14,* 6 (October 1996), 673–699.

83. Economides, N., and Himmelberg, C. Critical mass and network evolution in telecommunications. In G. Brock (ed.), *Toward a Competitive Telecommunication Industry.* Mahwah, NJ: Lawrence Erlbaum, 1995, pp. 47–63.

84. Edvardsson, B.; Gustafsson, A.; and Roos, I. Service portraits in service research: A critical review. *International Journal of Services Industry Management, 16,* 1 (2005), 107–121.

85. Eisenmann, T.R.; Parker, G.; and van Alstyne, M. Strategies for two-sided markets. *Harvard Business Review, 84,* 10 (October 2006), 92–101.

86. Erl, T. *Service-Oriented Architecture: A Field Guide to Integrating XML and Web Services.* Upper Saddle River, NJ: Prentice Hall, 2004.

87. Farrell, J., and Rabin, M. Cheap talk, coordination and entry. *Journal of Economic Perspectives, 10,* 3 (Summer 1996), 103–118.

88. Farrell, J., and Saloner, G. Standardization, compatibility, and innovation. *Rand Journal of Economics, 16,* 1 (Spring 1985), 70–83.

89. Farrell, J., and Saloner, G. Installed base and compatibility: Innovation, product preannouncement, and predation. *American Economic Review, 76,* 5 (December 1986), 940–955.

90. Farrell, J., and Saloner, G. Converters, compatibility, and the control of interfaces. *Journal of Industrial Economics, 40,* 1 (March 1992), 9–35.

91. Fichman, R.G. Real options and IT platform adoption: Implications for theory and practice. *Information Systems Research, 15,* 2 (March 2004), 132–154.

92. Fichman, R.G.; Keil, M.; and Tiwana, A. Beyond valuation: Options thinking in IT project management. *California Management Review, 47,* 2 (Winter 2005), 74–96.

93. Fisk, R.P.; Grove, S.J.; and John, J. *Interactive Services Marketing,* 2d ed. Boston: Houghton Mifflin, 2004.

94. Foley, J. IBM turns to cloud management. *InformationWeek* (November 13, 2008) (available at www.informationweek.com/cloud-computing/blog/archives/2008/11/want_a_clue_on.html).

95. Fornell, C. A national customer satisfaction barometer: The Swedish experience. *Journal of Marketing, 56,* 1 (January 1992), 1–18.

96. Fornell, C.; Johnson, M.D.; Anderson, E.W.; Cha, J.; and Bryant, B.E. The American customer satisfaction index: Nature, purpose and findings. *Journal of Marketing, 60,* 4 (October 1996), 39–50.

97. Forrester, J.W. *Industrial Dynamics.* Cambridge: MIT Press, 1961.

98. Foster, I. Service-oriented science. *Science, 308,* 5723 (May 6, 2005), 814–817.

99. Frei, F.X. Breaking the trade-off between efficiency and service. *Harvard Business Review, 88,* 11 (November 2006), 93–101.

100. Friedman, T.L. *The World Is Flat: A Brief History of the 21st Century.* New York: Farrar, Strauss and Giroux, 2005.

101. Froehle, C.M., and Roth, A.V. A resource process framework of new service development. *Production and Operations Management, 16,* 2 (March–April 2003), 169–188.

102. Froehle, C.M., and Roth, A.V. New measurement scales for evaluating perceptions of the technology-mediated customer service experience. *Journal of Operations Management, 22,* 1 (2004), 1–21.

103. Gaimon, C. Planning IT: Knowledge worker systems. *Management Science, 43,* 9 (September 1997), 1308–1328.

104. Gallaugher, J.M., and Wang, Y.M. Understanding network effects in software markets: Evidence from Web server pricing. *MIS Quarterly, 26,* 4 (December 2002), 303–327.

105. Gaynor, M., and Bradner, S. A real options framework to value network, protocol and service enhancements. *ACM SIGCOMM Computer Communication Review, 34,* 5 (October 2004), 31–38.

106. Gittell, J., and Weiss, L. Coordination networks within and across organizations: A multi-level framework. *Journal of Management Studies, 41,* 1 (September 2004), 127–153.

107. Goul, M., and Corral, K. Enterprise model management and next generation decision support. *Decision Support Systems, 43,* 3 (April 2007), 915–932.

108. Gowrisankaran, G., and Stavins, J. Network externalities and technology adoption: Lessons from electronic payment. *Rand Journal of Economics, 35,* 2 (Summer 2004), 260–276.

109. Granados, N.F.; Kauffman, R.J.; and King, B. How has electronic travel distribution been transformed? A test of the theory of newly vulnerable markets. *Journal of Management Information Systems, 25,* 2 (Fall 2008), 73–95.

110. Griffin, A., and Hauser, J.R. The voice of the customer. *Marketing Science, 12,* 1 (Winter 1993), 1–27.

111. Grobler, A.; Thun, J.H.; and Milling, P.M. System dynamics as a structural theory in operations management. *Production and Operations Management, 17,* 3 (2008) 373–384.

112. Grove, S.J.; Fisk, R.P.; and Laforge, M.C. Developing the impression management skills of the service worker: An application of Stanislavsky's principles in a service context. *Service Industry Journal, 24,* 2 (2004), 1–14.

113. Gupta, A.; Stahl, D.; and Whinston, A. A stochastic equilibrium model of Internet service prices. *Journal of Economic Dynamics and Control, 21,* 4–5 (May 1997), 697–722.

114. Gupta, S.; Lehman, D.R.; and Stewart, J.A. Valuing customers. *Journal of Marketing Research, 41,* 1 (February 2004), 7–18.

115. Hackenbroch, W., and Henneberger, M. Grid computing infrastructures and their value for risk management. In R.H. Sprague (ed.), *Proceedings of the 40th Hawaii International Conference on System Sciences.* Los Alamitos: IEEE Computer Society Press, 2007 (available at www.computer.org/plugins/dl/pdf/proceedings/hicss/2007/2755/00/27550063c.pdf?template=1&loginState=1&userData=anonymous-IP%253A%253A71.99.94.194).

116. Hauser, J.R.; Simester, D.I.; and Wernerfelt, B. Customer satisfaction incentives. *Marketing Science, 13,* 4 (Fall 1994), 327–350.

117. Heim, G.R., and Sinha, K.K. Service process configurations in electronic retailing: A taxonomic analysis of electronic food retailers. *Production and Operations Management, 11,* 1 (Spring 2002), 54–74.

118. Hewitt, C. ORGs for scalable, robust, privacy-friendly client cloud computing. *IEEE Internet Computer, 12,* 5 (September–October 2008), 96–99.

119. Hodgson, J. With Azure, Microsoft makes big bet on cloud computing. *CNN Money,* November 12, 2008.

120. Hoetker, G. Do modular products lead to modular organizations? *Strategic Management Journal, 27,* 6 (June 2006), 501–518.

121. Horn, P. The new discipline of services science. *BusinessWeek* (January 21, 2005) (available at www.businessweek.com/technology/content/jan2005/tc20050121_8020.htm).

122. Housel, T., and Kanevsky, V.A. Reengineering business processes: A complexity theory approach to value added. *INFOR, 33,* 4 (November 1995), 248–262.

123. IBM creates new academic curriculum to improve services innovation. IBM, T.J. Watson Research Center, Yorktown Heights, NY, May 23, 2005.
124. IBM opens cloud computing centers in Africa, China. *On-Demand Enterprise,* June 30, 2008.
125. IDC: SOA offers tremendous opportunity for service providers. *Grid Today,* April 10, 2006.
126. Iqbal, Z.; Verma, R.; and Baran, R. Understanding customer choices and preferences for transaction-based e-services. *Journal of Services Research, 6,* 1 (August 2003), 51–65.
127. Jain, S., and Kannan, P.K. Pricing of information products on online servers: Issues, models, and analysis. *Management Science, 48,* 9 (September 2002), 1132–1142.
128. John, J.; Grove, S.J.; and Fisk, R.P. Improvisation in service performances: Lessons from jazz. *Managing Service Quality, 16,* 3 (2006), 247–267.
129. Johnson, M., and Gustafsson, A. *Improving Customer Satisfaction, Loyalty and Profit: An Integrated Measurement and Management System.* San Francisco: Jossey-Bass, 2000.
130. Jorion, P. *Value-at-Risk: The New Benchmark for Controlling Market Risk,* 3d ed. New York: Irwin, 2007.
131. Kamakura, W.A.; Mittal, V.; de Rosa, F.; and Mazzon, J.A. Assessing the service profit chain. *Marketing Science, 21,* 3 (July 2002), 294–317.
132. Kannan, P.K., and Proenca, J.F. Design of service systems under variability: Research issues. In R.H. Sprague (ed.), *Proceedings of the 41st Hawaii International Conference on System Sciences.* Los Alamitos: IEEE Computer Society Press, 2008 (available at www.computer.org/plugins/dl/pdf/proceedings/hicss/2008/3075/00/30750116.pdf?template=1&loginState=1&userData=anonymous-IP%253A%253A71.99.94.194).
133. Kannan, P.K.; Pope, B.K.; and Jain, S. Pricing digital content product lines: A model and application for the National Academies Press. *Marketing Science, 28,* 4 (July–August) 2009, 620–636.
134. Karimi, J.; Gupta, Y.P.; and Somers, T.M. Impact of competitive strategy and information technology maturity on firms' strategic response to globalization. *Journal of Management Information Systems, 12,* 4 (Spring 1996), 55–88.
135. Karmakar, U. Will you survive the services revolution? *Harvard Business Review, 82,* 6 (June 2004), 100–107.
136. Katz, M., and Shapiro, C. Network externalities, competition, and compatibility. *American Economic Review, 75,* 3 (June 1985), 424–440.
137. Kauffman, R.J., and Li, X. Technology competition and optimal investment timing: A real options perspective. *IEEE Transactions on Engineering Management, 52,* 1 (January 2005), 15–30.
138. Kauffman, R.J., and Mohtadi, H. Proprietary and open systems adoption: Risk-augmented transactions cost perspective. *Journal of Management Information Systems, 21,* 1 (Summer 2004), 137–166.
139. Kauffman, R.J., and Sougstad, R. Risk management of IT services contract portfolios: The profit-at-risk approach. *Journal of Management Information Systems, 25,* 1 (Summer 2008), 17–48.
140. Kauffman, R.J., and Sougstad, R. Value-at-risk in services-oriented systems and technology investments: A framework for managing project portfolio uncertainties. *International Journal of Services Science, 1,* 3 (2008), 225–246.
141. Kauffman, R.J., and Tsai, J.Y. The unified procurement strategy for enterprise software: A test of the "move to the middle" hypothesis. *Journal of Management Information Systems, 26,* 2 (Fall 2009), 177–204.
142. Kauffman, R.J., and Walden, E. Economics and electronic commerce: Survey and directions for research. *International Journal of Electronic Commerce, 5,* 4 (Summer 2001), 5–116.
143. Kay, R. QuickStudy: Cloud computing—Users can hook into the power of "out there." *Computerworld* (May 8, 2008) (available at www.computerworld.com/s/article/321699/Cloud_Computing).
144. Keen, P.G., and McDonald, M.P. *The eProcess Edge: Creating Customer Value and Business Wealth in the Internet Era.* New York: McGraw-Hill, 2000.

145. Kenyon, C. Optimal price design for variable capacity outsourcing contracts. *Journal of Revenue and Pricing Management, 4,* 2 (April 2005), 124–155.

146. Kim, J. Cheap talk and reputation in repeated pre-trial negotiation. *Rand Journal of Economics, 27,* 4 (Winter 1996), 787–802.

147. Kimes, S.E. A strategic approach to yield management. In A. Ingold, U. McMahon-Beattie, and I. Yeoman (eds.), *Yield Management: Strategies for the Service Industries,* 2d ed. London: International Thomson Business Press, 2001, pp. 3–14.

148. Knorr, E., and Gruman, G. What cloud computing really means. *InfoWorld* (April 7, 2008) (available at www.infoworld.com/article/08/04/07/15FE-cloud-computing-reality_1.html).

149. Krajewski, L.J., and Ritzman, L.P. *Operations Management: Strategic and Analysis.* Englewood Cliffs, NJ: Prentice Hall, 2002.

150. Land, G.T. *Grow or Die: The Unifying Principle of Transformation.* New York: Delacorte Press, 1974.

151. Langlois, R.N. Modularity in technology and organization. *Journal of Economic Behavior and Organization, 49,* 1 (September 2002), 19–37.

152. Lee, J. Model-driven business transformation and the semantic web. *Communications of the ACM, 48,* 12 (December 2005), 75–78.

153. Lim, B., and Wen, J. Web services: An analysis of the technology, its benefits, and implementation difficulties. *Information Systems Management, 20,* 2 (Spring 2003), 49–57.

154. Lovelock, C.H. Technology: Servant or master in the delivery of services? In T.A. Swartz, D.E. Bowen, and S.W. Brown (eds.), *Advances in Services Marketing and Management.* Greenwich, CT: JAI Press, 1995, pp. 63–90.

155. Lovelock, C.H., and Gummesson, E. Whither service marketing? In search of a new paradigm and fresh perspectives. *Journal of Services Research, 7,* 1 (August 2004), 20–41.

156. Luftman, J.N., and McLean, E.R. Key issues for IT executives. *MIS Quarterly Executive, 3,* 2 (June 2004), 269–285.

157. Luftman, J.N.; Lewis, P.R.; and Oldach, S.H. Transforming the enterprise: The alignment of business and information technology strategies. *IBM Systems Journal, 32,* 1 (1993), 198–221.

158. Lusch, R.F., and Vargo, S.L. *The Service-Dominant Logic of Marketing: Dialog, Debate, and Directions.* Armonk, NY: M.E. Sharpe, 2006.

159. Lusch, R.F., and Vargo, S.L. Service-dominant logic: Reactions, reflections and refinements. *Marketing Theory, 6,* 3 (September 2006), 281–288.

160. Lusch, R.F.; Vargo, S.L.; and O'Brien, M. Competing through service: Insights from service-dominant logic. *Journal of Retailing, 83,* 1 (January 2007), 5–18.

161. Maglio, P.P.; Srinivasan, S.; Kreulen, J.T.; and Spohrer, J. Service systems, service scientists, SSME, and innovation. *Communications of the ACM, 49,* 7 (July 2006), 81–85.

162. Malone, T.W. Modeling coordination in organizations and markets. *Management Science, 33,* 10 (October 1987), 1317–1332.

163. Malone, T.W.; Yates, J.; and Benjamin, R.I. Electronic markets and electronic hierarchies. *Communications of the ACM, 30,* 6 (June 1987), 484–497.

164. Martin, C.L. The history, evolution and principles of services marketing: Poised for the new millennium. *Marketing Intelligence and Planning, 17,* 7 (1999), 324–328.

165. Meuter, M.; Ostrom, A.; Roundtree, R.; and Bitner, M. Self-service technologies: Understanding customer satisfaction with technology-based service encounters. *Journal of Marketing, 64,* 3 (July 2000), 50–64.

166. Moorthy, K.S., and Srinivasan, K. Signaling quality with a money back guarantee: The role of transaction costs. *Marketing Science, 14,* 4 (Fall 1995), 442–466.

167. Mukhopadhyay, T., and Kekre, S. Strategic and operational benefits of electronic integration in B2B procurement processes. *Management Science, 48,* 10 (October 2002), 1301–1313.

168. Nambisan, S. IS as a reference discipline for new product development. *MIS Quarterly, 27,* 1 (March 2003), 1–18.

169. Narasimhan, R., and Mahapatra, S. Decision models in global supply chain management. *Industrial Marketing and Management, 33,* 1 (January 2004), 21–27.

170. Novack, T.P.; Hoffman, D.L.; and Yung, Y.F. Measuring the customer experience in online environments: A structural modeling approach. *Marketing Science, 19,* 1 (Winter 2000), 22–42.

171. Oliva, R., and Sterman, J.D. Cutting corners and working overtime: Quality erosion in the service industry. *Management Science, 47,* 7 (July 2001), 894–914.

172. Oliver, R.L. A cognitive model of the antecedence and consequences of satisfaction decisions. *Journal of Marketing, 17,* 4 (November 1980), 46–49.

173. Oliver, R.L.; Rust, R.T.; and Varki, S. Customer delight: Foundations, findings, and managerial insight. *Journal of Retailing, 73,* 3 (Fall 1997), 311–336.

174. Orton, J., and Weick, K. Loosely coupled systems: A reconceptualization. *Academy of Management Review, 15,* 2 (April 1990), 203–223.

175. Overby, E.; Bharadwaj, A.; and Sambamurthy, V. Enterprise agility and the enabling role of information technology. *European Journal of Information Systems, 15,* 1 (February 2006), 20–131.

176. Padgett, J.; Haji, M.; and Djemame, K. SLA management in a service-oriented architecture. In O. Gervasi, M.L. Gavrilova, V. Kumar, A. Laganá, H.P. Lee, Y. Mun, D. Taniar, and C.J.K. Tan (eds.), *Computational Science and Its Application—ICCSA 2005: Lecture Notes in Computer Science,* vol. 3483. Berlin: Springer, 2005, pp. 1282–1291.

177. Padmanabhan, V., and Rao, R.C. Warranty policy and extended service contracts: Theory and an application to automobiles. *Marketing Science, 12,* 3 (Summer 1993), 230–247.

178. Pal, N., and Zimmerie, R. Service innovation: A framework for success. Working paper, eBusiness Research Center, Smeal College of Business, Pennsylvania State University, University Park, 2005.

179. Paleologo, G.A. Price-at-risk: A methodology for pricing utility computing services. *IBM Systems Journal, 43,* 1 (2004), 20–31.

180. Papazoglou, M.P., and Georgakopoulos, D. Service-oriented computing. *Communications of the ACM, 46,* 10 (October 2003), 25–28.

181. Papazoglou, M.P., and Heuvel, W.J. Service-oriented architectures: Approaches, technologies and research issues. *International Journal of Very Large Data Bases, 16,* 3 (July 2007), 389–415.

182. Parasuraman, A.; Berry, L.L.; and Zeithaml, V.A. SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing, 64,* 1 (Spring 1988), 12–40.

183. Parasuraman, A.; Zeithaml, V.A.; and Malhotra, A. E-S-Qual: A multiple item scale for measuring electronic service quality. *Journal of Services Research, 7,* 3 (February 2005) 213–233.

184. Pavlou, P.A., and El Sawy, O.A. From IT leveraging competence to competitive advantage in turbulent environments: The case of new product development. *Information Systems Research, 17,* 3 (September 2006), 198–227.

185. Peltz, C. Web services orchestration and choreography. *Computer, 36,* 10 (October 2003), 46–52.

186. Peppard, J. Managing IT as a portfolio of services. *European Management Journal, 21,* 4 (August 2003), 467–483.

187. Plummer, D.C.; Smulders, C.; Fiering, L.; Natis, Y.V.; Mingay, S.; Driver, M.; Fenn, J.; McLellan, L.; and Wilson, D. Gartner's top predictions for IT organizations and users, 2008 and beyond: Going green and self-healing. Gartner, Stamford, CT, January 8, 2008 (available at www.gartner.com/DisplayDocument?id=578409).

188. Quinn, J.E. The productivity paradox is false: Information technology empowers service performance. In T.A. Swartz, D.E. Bower, and S.W. Brown (eds.), *Advances in Services Marketing and Management.* Greenwich, CT: JAI Press, 1996, pp. 71–84.

189. Rai, A., and Sambamurthy, V. Editorial notes: The growth of interest in services management: Opportunities for information systems scholars. *Information Systems Research, 17,* 4 (December 2006), 327–331.

190. A reference model for service-oriented architecture. White paper, Service-Oriented Architecture Reference Model Technical Committee, Organization for Advancement of Structured Information Standards (OASIS), Billerica, MA, February 2006.

191. Reinartz, W.J., and Kumar, V. On the profitability of long-life customers in a noncontractual setting: An empirical investigation and implications for marketing. *Journal of Marketing, 64,* 4 (October 2000), 17–35.

192. Reinartz, W.J., and Kumar, V. The impact of customer relationship characteristics on profitable lifetime duration. *Journal of Marketing, 67,* 1 (January 2003), 77–99.

193. Reinartz, W.J.; Krafft, M.; and Hoyer, W. The customer relationship management process: Its measurement and impact on performance. *Journal of Marketing Research, 41,* 3 (August 2004), 293–305.

194. Ricadela, A. Computing heads for the clouds. *BusinessWeek* (November 16, 2007) (available at www.businessweek.com/technology/content/nov2007/tc20071116_379585.htm).

195. Ricciutti, M. Stallman: Cloud computing is "stupidity." *CNet News* (September 30, 2008) (available at http://news.cnet.com/8301-1001_3-10054253-92.html).

196. Roth, A.V. Neo-operations strategies: Linking capabilities-based competition to technology. In G.H. Gaynor (ed.), *The Handbook of Technology Management.* New York: McGraw-Hill, 1996, pp. 1–38.

197. Roth, A.V., and Menor, L. Insights into service operations management: A research agenda. *Production and Operations Management, 12,* 2 (2003), 145–164.

198. Rust, R.T., and Chung, T.S. Marketing models of services and relationships. *Marketing Science, 25,* 6 (November–December 2006), 560–580.

199. Rust, R.T., and Kannan, P.K. E-service: A new paradigm for business in the electronic environment. *Communications of the ACM, 46,* 6 (June 2003), 36–42.

200. Rust, R.T., and Miu, C. What academic research tells us about service. *Communications of the ACM, 49,* 7 (July 2006), 49–54.

201. Rust, R.T.; Zeithaml, V.A.; and Lemon, K.N. *Driving Customer Equity: How Customer Lifetime Value Is Reshaping Corporate Strategy.* New York: Free Press, 2000.

202. Rust, R.T.; Zeithaml, V.A.; and Lemon, K.N. Customer-centered brand management. *Harvard Business Review, 82,* 9 (September 2004), 110–118.

203. Sabherwal, R., and Chan, Y.E. Alignment between business and IS strategies: A study of prospectors, analyzers, and defenders. *Information Systems Research, 12,* 1 (March 2001), 11–33.

204. Saloner, G., and Shepard, A. Adoption of technologies with network effects: An empirical examination of the adoption of automated teller machines. *Rand Journal of Economics, 26,* 3 (Autumn 1995), 479–501.

205. Sambamurthy, V.; Bharadwaj, A.; and Grover, V. Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly, 27,* 2 (June 2003), 237–263.

206. Sampson, S.E. *Understanding Service Businesses: Applying Principles of Unified Services Theory,* 2d ed. New York: John Wiley, 2001.

207. Sampson, S.E., and Froehle, C.M. Foundations and implications of a proposed unified services theory. *Production and Operations Management, 15,* 2 (Summer 2006), 329–343.

208. Sargent, T.J., and Wallace, N. Rational expectations and the theory of economic policy. *Journal of Monetary Economics, 2,* 2 (January 1976), 169–183.

209. Satyavikas, V.K.; Demirkan, H.; and Goul, M. Toward Web services standards for fault tolerance capabilities in inter-organizational workflow management systems. In M. Jeckle and L.J. Zhang (eds.), *Web Services—ICWS-Europe 2003: Lecture Notes in Computer Science,* vol. 2853. Berlin: Springer, 2003, pp. 90–96.

210. Sawhney, M.S., and Eliashberg, J. A parsimonious model for forecasting gross box office revenues of motion pictures. *Marketing Science, 15,* 2 (Spring 1996), 113–131.

211. Scharfstein, D., and Stein, J. Herd behavior and investment. *American Economic Review, 80,* 3 (June 1990), 465–479.

212. Schilling, M.A. Toward a general modular systems theory and its application to interfirm product modularity. *Academy of Management Review, 25,* 2 (April 2000), 312–334.

213. Schneider, B.; White, S.S.; and Paul, M.C. Linking service climate and customer perceptions of service quality: Tests of a causal model. *Journal of Applied Psychology, 83,* 2 (April 1998) 150–163.

214. Schwartz, E.S., and Zozaya-Gorostiza, C. Investment under uncertainty in information technology: Acquisition and development projects. *Management Science, 49,* 1 (January 2003), 57–70.

215. Service-oriented architecture. *IBM Systems Journal, 44,* 4 (Special Issue, 2005) (available at www.research.ibm.com/journal/sj44-4.html).

216. Shugan, S.M., and Xie, J. Advance pricing of services and other implications of separating purchase and consumption. *Journal of Service Research, 2,* 3 (February 2000), 227–239.

217. Singh, M., and Huhns, M. *Service-Oriented Computing: Semantics, Processes, Agents.* New York: John Wiley, 2004.

218. Spence, A.M. Job market signaling. *Quarterly Journal of Economics, 87,* 3 (August 1973), 355–374.

219. Spence, A.M. *Market Signaling: Informational Transfer in Hiring and Related Screening Processes.* Cambridge: Harvard University Press, 1974.

220. Spohrer, J., and Maglio, P.P. The emergence of service science: Toward systematic service innovations to accelerate co-creation of value. *Production and Operations Management, 17,* 3 (May–June 2008), 238–246.

221. Spohrer, J., and Maglio, P.P. Fundamentals of service science. *Journal of the Academy of Marketing Science, 36,* 1 (March 2008), 18–20.

222. Spohrer, J.; Maglio, P.P.; Bailey, J.; and Gruhl, D. Steps toward a science of service systems. *IEEE Computer, 40,* 1 (January 2007), 71–78.

223. Spulber, D. *Market Microstructure: Intermediaries and the Theory of the Firm.* Cambridge: Cambridge University Press, 1999.

224. Stock exchange for grid computing? ICT Results, Brussels, Belgium (February 25, 2008) (available at http://cordis.europa.eu/ictresults/index.cfm?section=news&tpl=article&ID=89550).

225. Suleman, H. Analysis and evaluation of service-oriented architectures for digital libraries. In C. Türker, M. Agosti, and H.J. Schek (eds.), *Peer-to-Peer, Grid, and Service-Orientation in Digital Library Architectures: Lecture Notes in Computer Science,* vol. 3664. Berlin: Springer, 2005, pp. 130–146.

226. Taleb, N. *The Black Swan: The Impact of the Highly Improbable.* New York: Random House, 2007.

227. Tansey, B., and Stroulia, E. Valuating software service development: Integrating COCOMO II and real options theory. In H. Zhu (ed.), *Proceedings of the 1st International Conference on Software Engineering.* Los Alamitos, CA: IEEE Computer Society Press, 2007, p. 87.

228. Taudes, A.; Feurstein, M.; and Mild, A. Option analysis of software platform decisions: A case study. *MIS Quarterly, 24,* 2 (June 2000), 227–243.

229. Teece, D.; Pisano, G.; and Shuen, A. Dynamic capabilities and strategic management. *Strategic Management Journal, 18,* 7 (July 1997), 509–533.

230. Urban, S.; Kambhampati, S.; Dietrich, S.; Jin, Y.; and Sundermier, A. An event processing system for rule-based component integration. In I. Seruca, J. Cordiero, S. Hammoudi, and J. Felipe (eds.), *Enterprise Information Systems VI: Lecture Notes in Computer Science,* vol. 4495. Berlin: Springer-Verlag, 2006, pp. 312–319.

231. Vargo, S.L., and Lusch, R.F. Evolving to a new dominant logic for marketing. *Journal of Marketing, 68,* 1 (January 2004), 1–17.

232. Vollmer, K.; Gilpin, M.; and Schwaber, C. Integration in a service-oriented world. Forrester Research, Cambridge, MA, July 6, 2004 (available at www.forrester.com/rb/Research/integration_in_service-oriented_world/q/id/34742/t/2).

233. Voss, C.; Roth, A.V.; and Chase, R.B. Experience, service operations strategy, and services as destinations: Foundations and exploratory investigation. *Production and Operations Management, 17,* 3 (2008), 247–266.

234. Williamson, O.E. Transaction cost economics: The governance of contractual relationships. *Journal of Law and Economics, 22,* 2 (October 1979), 233–261.

235. Xue, G.; Chen, L.; and Thulasiraman, K. Quality of service and quality of protection issues in preplanned recovery schemes using redundant trees. *IEEE Journal of Selected Areas in Communications, 21,* 8 (October 2003), 1332–1345.

236. Xue, M., and Harker, P.T. Customer efficiency: Concept and its impact on e-business management. *Journal of Services Research, 4,* 4 (May 2002), 253–267.

237. Zeithaml, V.A., and Bitner, M.J. *Service Marketing: Integrating Customer Focus Across the Firm,* 3d ed. Boston: Irwin McGraw-Hill, 2002.

238. Zeithaml, V.A.; Bitner, M.J.; and Gremler, D. *Services Marketing: Integrating Customer Focus Across the Firm,* 4th ed. New York: McGraw-Hill, 2006.

239. Zeithaml, V.A.; Parasuraman, A.; and Malhotra, A. A conceptual framework for understanding e-service quality: Implications for future research and managerial practice. Report 00–115, Marketing Science Institute, Cambridge, MA, 2000.

240. Zhao, J.L.; Tanniru, M.; and Zhang, L.J. Services computing as the foundation of enterprise agility: Overview of recent advances and introduction to the special issue. *Information Systems Frontiers, 9,* 1 (2007), 1–8.