Technological Innovation in Organizations and Their Ecosystems

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With the massive adoption of ICT by organizations in the past decade, business managers, academics, and policy makers are addressing questions such as "Is ICT adoption really transforming the enterprise?" "If so, how should 'transformation' be effectively managed?" "What are the implications for future research and management practice?"

In an increasingly networked environment, ICT requires a different governance approach since ICT infrastructures need to be conceived, deployed, and managed across organizational boundaries. ICT stakeholders are part of an ecosystem that involves suppliers, partners, competitors, customers, systems providers, institutions, and government. Today the locus of competence and innovation is moving away from the company to the ecosystem, and value is being cocreated by the different actors in the network. The implications for management and research are many, and they are significant.

Adoption of ICT Innovations and Organizational Change

Many organizations adopt ICT not just to do the same old things more efficiently but also to do things differently (process innovation) or do new things (product innovation). Thus, ICT adoption often implies innovation and change. But what drives organizations to adopt an innovation in the first place? Innovations are adopted primarily on the basis of some expected organizational benefits. Research has shown, however, that compatibility and complexity also influence the likelihood of adoption of an innovation (Tornatzky and Klein, 1982; Rogers, 1983). This suggests that the specific organizational context in which a new ICT is introduced determines the extent to which it is compatible with existing

practices. Likewise, the level of ICT literacy and experience of the potential adopters will determine the perceived complexity of the ICT application. Thus, the factors influencing adoption are not only the features of the ICT being adopted (the "attributes of the innovation") but also the characteristics of the organizational context (such as people, processes, systems, structure, or culture).

An innovation's adoption is also affected by peer pressure attributed to the "diffusion effect," that is, the cumulatively increasing degree of influence upon an individual or an organization to adopt or reject an innovation, resulting from the activation of peer networks in a social system (Rogers, 1983). In a business environment, the diffusion effect translates into competitive pressure. Firms may end up adopting because of perceived competitive necessity (or even sheer imitation) rather than as a result of a cost/benefit assessment. That was certainly the case with many e-commerce projects before the "dot-com" bubble burst. ICT adopted on this basis yielded little or no return on investment.

Technology diffusion is also a knowledge management process. As the cumulative number of adopters increases, the collective knowledge about the technology also increases, and this influences the adoption decision. The key factor is knowledge rather than peer pressure. This is particularly true of complex technologies where adopters face "learning by using" (Rosenberg, 1982). This perspective views technology diffusion in terms of organizational learning, skill development, and knowledge barriers (Attewell, 1992). Firms may delay adoption of complex technologies until they obtain sufficient technical know-how to implement and operate successfully. Know-how and organizational learning are thus potential barriers to adoption. When knowledge barriers are overcome, diffusion speeds up.

Successful technology implementations, however, require both behavioral changes and organizational changes. The organizational change literature views implementation of ICT as a dynamic process involving the introduction of a technical change into an existing social system. From this perspective, organizations need to manage the introduction of technology as a change strategy (Beer, 1980; Kotter et al., 1979), and this requires management commitment, political support, and resources. This perspective suggests that effective IT implementation requires the alignment of the technology and the organization that operates it.

Alignment, in practice, can be achieved essentially in three ways (McKersie and Walton, 1991). Some of the enabling conditions may already exist or can be developed in anticipation of the introduction of the ICT system, and the organization can "pull" the technology into place by the users rather than push it into place by managers. Alternatively, managers can design the new technology and the operating organization at the same time. This pattern has the advantage of allowing mutual adaptation of the technical and social subsystems of an ICT implementation (Leonard-Barton and Kraus, 1988). In a third option, management focuses exclusively on implementing the technology, letting the technology drive subsequent organizational adaptation. In this case, a firm moves ahead with the introduction of ICT, leaving existing organizational arrangements in place, and subsequently attends to organizational changes on a responsive or adaptive basis. In conclusion, ICT adoption is intrinsically associated with organizational change, and therefore an effective implementation requires necessarily good change management.

From Organizational Change to Business Performance: Productivity Paradox or Management Paradox?

Research on the link between organization design and business performance has a long tradition (e.g., Chandler, 1962; Thompson, 1967; Galbraith, 1977; Caves, 1980; Quinn, 1980; Porter, 1985). In the past decade, the role of ICT as enabler of organizational design and organizational transformation became a topic of interest in both the information systems literature as well as the general management literature (Hammer, 1990; Scott-Morton, 1991; Davenport, 1993; Hammer and Champy, 1993). By redesigning the way existing business processes were performed and using ICT to enable new ones, some organizations were able to achieve significant improvements in key business drivers, such as cost, quality, service levels, or lead times.

Yet these successes did not seem to make an impact on productivity figures at the macroeconomic level. Robert Solow's famous quip that "You can see the computer age everywhere but in the productivity statistics" provoked a great deal of debate. If IT investments do not yield any clear advantages, why do so many organizations continue to invest heavily in IT? The suggestion that IT does not bring benefits to

organizations seems to go against intuition and common sense. Subsequent research has tried to explain away the "IT productivity paradox" (e.g., Brynjolfsson and Hitt, 1998; Willcocks and Lester, 1999; Triplett, 1999).

A closer look at the IT productivity paradox reveals that it has several facets, depending on the level of analysis (Pilat and Wyckoff, in this book). Traditionally, the statistics at the macroeconomic level have been inconclusive. Increases in IT investment spending levels in some developed countries have coincided with a decrease in the productivity growth. Industry-level productivity figures suggest that the apparent decrease in productivity growth is largely due to a limited growth in productivity of office work in the service industry, which in turn has had the highest IT spending levels.

At the organizational level things look different. Case studies show that some organizations have been able to derive large benefits through IT (e.g., Wal-Mart, Dell Computer, Charles Schwab). Pilat and Wyckoff, as well as Brynjolfsson and Hitt (also in this book), show that the use of ICT is positively linked to firm performance. Other studies reveal substantial differences between organizations that utilize IT in a successful versus an unsuccessful way (Brynjolfsson and Hitt, 1998). This variation may be due to differences in organizational conditions such as ICT experience, top management commitment, and organizational politics (Weill, 1990; Strassmann, 1990).

The IT productivity paradox should not be a disquieting problem for managers. After all, there seem to be many opportunities for individual organizations to use IT in innovative and profitable ways. The question for managers is not whether IT pays off in general but what IT applications should be deployed in their respective organizations. In the end, the difference between IT success or failure may well be the ability to evaluate the benefits and strategic potential versus the cost and risks of proposed IT investments, and having the right management processes in place to plan and execute IT projects.

Value Creation and IT Governance

Over the years the focus of IT management has been shifting from efficiency-related issues to the question of how to deliver business value with

IT. In the early days, IT managers were only asked to complete IT projects within time and budget constraints. This may have worked in a period when IT merely had automating effects, which could easily be justified on the basis of cost savings, but it has become unacceptable today, when investments have "transforming" effects, e.g., improving quality, flexibility, and the innovation ability of organizations.

Research findings suggest that good evaluation and decision-making practices might well contribute to the ultimate value to be gained from investments (Weill and Olsen, 1989; Willcocks, 1994). Firms that better assess what they expect from their ICT projects and also manage ICT investments from this perspective seem to be more successful than others that do not have formal evaluation procedures in place.

The organizational structures and processes to ensure that ICT delivers value and is aligned with the strategic goals of the firm are known as "ICT governance." ICT governance brings together the different stakeholders to assess and take responsibility for ICT projects. The explicit attention to investment evaluation and stakeholder involvement helps create a shared vision and generate commitment to the business outcome.

Stakeholders, however, have personal views on the desirability of each project. Conflicting interests may complicate cooperation, and communication problems may arise from differences in background and expertise. ICT decision making will always have a political nature to some extent (Markus, 1983). Research on ICT governance should target the difficulties that such a process faces and the ways to overcome them. These lie in the areas of benefits assessment and management, cost analysis, risk management, and, also, stakeholder communications and organizational politics (Renkema, 1999).

Transcending Organizational Boundaries

Although effective management of organizational change is imperative for achieving IT benefits, the cases of leading companies (e.g., Wal-Mart, Dell, and others) also indicate that the locus of change and innovation is no longer confined within the boundaries of the firm. Some of the most dramatic changes, in fact, have taken place at the level of supply chains or business networks or on an industry level.

Kraemer and Dedrick (in this book) analyze the transformation of the PC industry, which since the mid-1990s has been using direct sales channels, demand-driven production, and modular production networks. Within these networks, firms are flexible in designing value chains for different products and markets, with each firm selecting a different mix that takes into account its own capabilities and strategies. The structure of the industry's global production network changed, making it possible to coordinate design, production, and logistics on a regional or global basis. As a result, PC makers have been able to locate these activities where costs are low and key skills are available, or close to major markets. Also, the use of IT, the Internet, and e-commerce have enabled and supported the shift from supply-driven to demand-driven production and the creation of more flexible, information-intensive value chains to support this complex process. This change has led to dramatic reductions in inventory, better use of assets, and leaner operations throughout the industry.

Kraemer and Dedrick conclude that the sources of competitive advantage in the new IT-enabled organization are the substitution of information for inventory, better matching of supply and demand, and the ability to tap into external economies in the global production network. External economies can be accessed by any firm, but demand-driven organizations are best positioned to take advantage of these economies because they can use real-time information to drive the production network in response to demand changes.

In another chapter of this book, Boy Lüthje examines new models of outsourced manufacturing (contract manufacturing and electronics manufacturing services) in globalized production networks in the electronics industry. He analyzes the interaction of new information networks with the restructuring of production, work, and the global division of labor. He concludes that information technology is not the driver of organizational change per se but part of a complex shift in the social division of labor that ultimately is related to the demise of vertically integrated mass manufacturing. In this context, information technology and Internet-based models of supply-chain management do facilitate vertical specialization.

Lüthje also raises the question of network governance. He discusses the trend in centralization of supply-chain management in electronic

components. The issue is how to orchestrate complex networks of corporate actors and their interaction in global marketplaces. This suggests that further research should address coordination and regulation issues in networks, as well as the role of standards and institutions.

Toward Customer-Centric Ecosystems

As discussed earlier, one of the most significant industry-level transformations has been the shift from supply-driven to demand-driven value chains. This "reversal" of the value chain together with the Internet empowers consumers in ways that were unimaginable just some years ago. Consumers can create virtual communities and engage in an active dialogue with manufacturers of products and services. At the same time, consumers constitute a source of knowledge that companies can exploit. This transforms the traditional notion of "core competence" (Prahalad and Hamel, 1990). Competence now becomes a function of the collective knowledge available in the ecosystem, i.e., an enhanced network comprising the company, its suppliers, its distributors, its customers, its partners, and its partners' suppliers and customers.

From a research viewpoint, this implies that the unit of analysis needs to shift from the (extended) enterprise to the larger ecosystem. The firm becomes a node in the enhanced network of organizations in the ecosystem. The implication for business managers is that this ecosystem provides opportunities to address customer needs in a unique way and allows value chains to be redesigned around the consumer. In this customer-centric approach, firms are no longer producers of products or services but (co)developers of customer experiences. And customers can play an active role in this.

In order to harness customer competence, companies have to engage customers in an active, explicit, and ongoing dialogue, mobilize consumer communities, manage customer diversity, and cocreate personalized experiences with customers (Prahalad and Ramaswamy, 2000). Organizations that can "sense and respond" rapidly by moving information to mobilize resources and knowledge in the network will emerge as the "winners" in the network economy (Bradley and Nolan, 1998; Kraemer and Dedrick, in this book).

Managing customer experiences is about managing the interface between a company and its customers. Products and services will have to be more "intelligent" and adapt themselves to changing users' needs, not the other way around (Prahalad and Ramaswamy, 2000). The method by which customers and companies communicate is also an integral part of creating an experience. Companies will have to manage—and integrate—several distribution channels and ensure that the quality of fulfillment and the personalized experience are consistent across channels. The challenge will be to develop the infrastructures needed to support such a multichannel, multipartner network.

The Enabling ICT Infrastructure

Extended enterprises, supply chains, business ecosystems, and industrial clusters are complex systems based on the networking of organizations, the cooperation of the players, and flexible access to resources. They are communities that share business, knowledge, and infrastructure in a highly dynamic way. In order to enable the network of partners to collaborate, sense consumers' needs, and deploy resources rapidly, a new technology infrastructure is required.

Such infrastructure calls for a dynamic aggregation of network and software services to facilitate interorganizational interactions. The key elements of the infrastructure are software components and agents that show evolutionary and self-organizing behavior, i.e., they are subject to evolution and to self-selection based on their ability to adapt to the local business requirements (Nachira, 2002). Future research should focus on network architectures that are pervasive, adaptive, self-configuring, and self-healing.

Additional approaches may include modeling. In another chapter in this book, Nagurney introduces the concept of "supernetworks," that is, networks that are "above and beyond" existing networks. Her supernetwork framework captures decision making by economic agents (e.g., consumers, producers, and intermediaries) in the context of today's networked economy. The decisions often entail trade-offs between the use of physical versus communication networks. Such a framework can be used to model the behavior of individual decision makers as well as their interactions in the complex network system.

The Death of Distance?

Much has been made of the potential of ICT to enable a despatialization of economic activity. Cairncross (1997 and 2001) posits that, with the introduction of the Internet and new communications technologies, distance as a relevant factor in the conduct of business is becoming irrelevant. She contends that the "death of distance" will be the single most important economic force shaping all of society over the next half century.

Despite the bold predictions, however, geography and location still matter. Porter's identification of local agglomerations, based on a large-scale empirical analysis of the internationally competitive industries for several countries, has been especially influential, and his term "industrial cluster" has become the standard concept in this field (Porter, 1998, 2001). Also, the work of Krugman (1991, 1996) has been concerned with the economic theory of the spatial localization of industry. Both authors have argued that the economic geography of a nation is key to understanding its growth and international competitiveness.

Clusters facilitate the transmission of knowledge—particularly tacit knowledge, which cannot move as freely or easily from place to place as codified knowledge. Research on ecosystems should thus include a knowledge management perspective. In another chapter in this book, Mason and Apte provide a model for how knowledge transforms enterprises. Further research could focus on the potential contribution of ICTs that gives priority to socially mediated tacit skill sets and learning processes as prerequisites for the effective use of these technologies within a complex adaptive system.

The use of diverse combinations of ICTs within and between clusters is likely to have implications for the meaning of proximity. In traditional clusters, the need for physical proximity has led to regional agglomerations. But how will new ICTs affect traditionally perceived needs for physical proximity and introduce "virtual" proximity as a complement to physical proximity? Can "virtual" clusters be expected to emerge and/or develop, in part, as a result of the widespread application of ICTs? What combinations of physically proximate and "virtual" arrangements best augment the social and economic performance of networked clusters? Future research should look at clusters as geographically proximate

complex organizational systems of learning and economic and social activity that are globally networked and enabled by the effective use of ICTs (see O'Callaghan, in this book).

Conclusions and Research Directions

ICT is the tool that helps design, change, innovate, and learn in the emerging models of the network economy. By examining ICT-enabled transformation from various perspectives, the authors in this book illuminate the processes of adoption and diffusion of ICT and the role that ICT plays in organizational design, process change, knowledge management, and value creation. It has implications for management, policy, and research.

Future research on ICT-enabled transformation should start by changing the unit of analysis and focus on understanding the new (inter)organizational forms, the new drivers of value, the new ICT infrastructures, and the new governance approach. The traditional business paradigm revolved around the firm. The new paradigm regards the firm as a node in an ecosystem—a network of partners that collaborate to create customer experiences and intelligent products that can adapt themselves to evolving customers needs.

Research should address emerging issues such as, How is value created and apportioned among the players in the ecosystem? How do companies in the ecosystem establish a dialogue with consumers? How can ICT be used to integrate the different partners seamlessly and provide unique customer experiences? How can resources be deployed rapidly to respond in real time? How does the network deal with complexity? What governance approach should be put in place to deploy and manage interorganizational ICTs when the stakeholders are a constellation of partners interacting in the ecosystem? What institutional arrangements will foster or impede the development and effectiveness of the new systemic models? What are the policy implications?

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