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INFORMATION TECHNOLOGY AS COMPETITIVE ADVANTAGE: THE ROLE OF HUMAN, BUSINESS, AND TECHNOLOGY RESOURCES

THOMAS C. POWELL and ANNE DENT-MICALLEF
Bryant College, Smithfield, Rhode Island, U.S.A.

This paper investigates linkages between information technology (IT) and firm performance. Although showing recent signs of advance, the existing IT literature still relies heavily on case studies, anecdotes, and consultants' frameworks, with little solid empirical work or synthesis of findings. This paper examines the IT literature, develops an integrative, resource-based theoretical framework, and presents results from a new empirical study in the retail industry. The findings show that ITs alone have not produced sustainable performance advantages in the retail industry, but that some firms have gained advantages by using ITs to leverage intangible, complementary human and business resources such as flexible culture, strategic planning–IT integration, and supplier relationships. The results support the resource-based approach, and help to explain why some firms outperform others using the same ITs, and why successful IT users often fail to sustain IT-based competitive advantages. © 1997 by John Wiley & Sons, Ltd.

INTRODUCTION

As the field of strategic management has expanded, strategy researchers and practitioners have shown increasing interest in the role of information technology (IT) in strategy formulation and implementation, and in its impacts on financial performance (e.g., Sabherwal and King, 1991; Holland, Lockett, and Blackman, 1992; Henderson and Venkatraman, 1993; Kettinger *et al*., 1994). However, the literature is fragmented and far-flung, and—despite some recent advances—weighs heavily toward case studies, anecdotes, and conceptual frameworks, with insufficient empirical work and minimal synthesis of findings. This paper attempts to redress this imbalance by examining and integrating IT's role in producing competitive advantage, and presenting results from a new empirical study in the retail industry.

Contrary to the prevailing case studies and anecdotes, the findings suggest that, owing to IT imitation by competitors, ITs have not, in and of themselves, produced sustained performance advantages. The resource-based 'strategic necessity hypothesis' (Clemons and Row, 1991) suggests, and the data corroborate, that IT creates advantage by leveraging or exploiting preexisting, complementary human and business resources. In the retail industry, sophisticated IT users did not generally outperform less sophisticated users, but those that combined IT with critical complementary resources did gain performance advantages. The results provide support for the resource-based approach, and help to explain apparent anomalies in the existing literature, in which some firms experience spectacular IT success while others lag and struggle, and in which spectacular successes seem singularly difficult to sustain.

Key words: information technology; competitive advantage; resource-based view

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INFORMATION TECHNOLOGY, STRATEGY, AND FIRM PERFORMANCE

Orlikowski and Gash (1992: 2) defined IT as ‘any form of computer-based information system, including mainframe as well as microcomputer applications.’ In business applications, the range and strategic impacts of such systems are vast; for example

- In pharmaceuticals distribution, McKesson provides its pharmacists with computer terminals that allow them to enter orders directly, simultaneously improving customer service and increasing switching costs.
- Federal Express drivers use hand-held computers and a sophisticated data management system that improve service and reduce costs, making overnight delivery services profitable and affordable to customers.
- Merrill Lynch introduced the Cash Management Account (CMA), based on an information system that combined customers’ checking, savings, credit card, and securities accounts into a single statement, automatically investing unused funds in interest-bearing money market funds.
- Xerox provides master production schedules online to suppliers to facilitate just-in-time deliveries, reduced inventory costs, and improved supplier relationships.
- Large retailers like Toys R Us and Wal-Mart use sophisticated inventory management technologies, including electronic data interchange with suppliers, to increase operational efficiencies and improve services.

Do ITs produce sustainable competitive advantages? Until recently, the IT literature seemed almost uniformly positive, focusing on case studies of spectacular IT successes—e.g., the American Airlines SABRE reservations system (Buday, 1986) and Merrill Lynch’s CMA (Wiseman, 1985)—and on conceptual frameworks designed to encourage and assist managers in IT implementation (King, 1978, 1984; Rockart, 1979; Parsons, 1983; McFarland, 1984). The case evidence suggested, for example, that American Airlines had not only gained direct strategic advantages over late-moving rivals such as Pan Am, but had significantly altered industry structure by creating switching costs among reservation agents and erecting IT-based entry barriers. The conceptual works argued for IT innovation and sophistication based on its potential for altering a full range of strategic and industry structure variables, including cost positions, scale economies and power relations with buyers and suppliers (Benjamin *et al*., 1984; Cash and Konsynski, 1985; Porter, 1985; Clemons, 1986).

From the outset, IT researchers advocated tight IT–strategy linkages, asserting that IT affects firm strategies, that strategies have IT implications, and that firms must somehow integrate strategic thrusts with IT capabilities (Rackoff, Wiseman, and Ullrich, 1985; Bakos and Treacy, 1986; Beath and Ives, 1986). Porter and Millar (1985), for example, related IT to the value chain, concluding that the main strategic purpose of IT is to coordinate activities in the chain; Rackoff *et al*. (1985) concluded that IT should support competitive thrusts such as cost leadership, differentiation, innovation, growth, and external alliances; and Rockart and Short (1989) argued that ITs serve primarily to ‘manage organizational interdependence,’ i.e., to solve coordination problems among departments and strategic business units.

A number of researchers examined the conditions under which ITs create sustainable advantages. Porter (1985), for example, focused on first-mover advantages, arguing that technological advantage arises when first-mover advantages (such as preempting customers through switching costs) outweight first-mover disadvantages (such as development costs and learning curves). Clemons (1986) distinguished between externally focused applications—i.e., those that connect the firm with customers or suppliers (such as ATMs, SABRE and the McKesson system)—and internally focused applications, i.e., those that improve internal efficiencies (such as factory automation systems). Citing the familiar case examples, the author suggested that external applications tended to produce advantages based on switching costs, whereas internal applications tended to produce advantages based on scale economies, managerial expertise and efficiencies. Neo (1988), analyzing 14 well-known IT cases, concluded that the most successful IT implementers were those that had already implemented similar systems, having built an infrastructure of IT experience and learning.

In sum, the pre-1990 IT literature focused on the strategic importance of IT adoption and innovation, and reflected a general optimism concerning IT's potential for creating competitive advantage. But there were a few significant caveats. In the ominously titled 'Information technology as a competitive burden,' Warner (1987) focused on the risks and costs of IT investments, and on the difficulties of integrating IT with strategy. Clemons (1986) also acknowledged that, although IT had clearly produced advantages in a few spectacular cases, researchers still knew relatively little about IT's impacts on most firms. According to Clemons (1986: 131): 'Surely much is media hype or current business fad … There is now a large, and largely anecdotal, literature, most of it referencing similar stories of technologically directed competitive triumphs. How much do we understand? … How many of the stories are true, or accurately reported?'

Recently, challenges to the earlier optimism have arisen from two additional sources. First, the emerging empirical evidence, though scant, is telling a different story. In a retail banking industry study, Banker and Kauffman (1988) found little or no significant connection between ATM adoption and performance and, in a follow-up study, Floyd and Wooldridge (1990) found no overall connection between ATM adoption and performance, with a positive correlation between performance and product IT offset by a negative correlation with process IT. Moreover, in a retrospective examination of 30 well-known IT cases from the 1970s and early 1980s, Kettinger *et al.* (1994) found that, within 5 years of IT implementation, 21 of the 30 firms had experienced competitive declines either in market share, profits, or both. In a study involving 31 IT executives, Mahmood and Soon (1991) reported that, in most industries, ITs had no discernible impact on entry barriers, but that when impacts were present they tended toward reducing, not increasing, entry barriers. In a study connecting technology policy and strategy, Zahra and Covin (1993) found no direct technology–performance connection. And in Neo's (1988) study, ITs *per se* had little to do with IT performance, which was driven more by IT-oriented strategic planning and management vision and support.

Aside from recent empirical findings, another major challenge to earlier optimism has arisen out of resource-based theory (Rumelt, 1987; Teece, 1987; Barney, 1991), which has emerged in recent years as a potential integrating paradigm for strategy research (Mahoney and Pandian, 1992; Peteraf, 1993). Resource-based theory begins with the notion of resource heterogeneity, arguing that firms hold heterogeneous resource portfolios—whether by history, accident, or design—and that this resource heterogeneity is responsible for observed variability in financial returns across firms (Peteraf, 1993). If a firm produces consistently superior returns, competitors will seek causal connections among resources and performance, and will attempt either to imitate high-performing resources, acquire them in factor markets, or to develop alternative resources that produce similar benefits (Dierickx and Cool, 1989). As such, firms achieve sustained performance advantages by accumulating resource portfolios that produce economic value, are relatively scarce, and can sustain competitive attempts at imitation, acquisition, or substitution (Barney, 1986a).

Valuable, scarce resources may survive competitive imitation if protected by imitation barriers, or 'isolating mechanisms' (Rumelt, 1984), such as: (1) *time compression diseconomies*—a resource may require accumulation over time through learning, experience, firm-specific knowledge, or trained proficiency in a skill; (2) *historical uniqueness (first-mover advantages)*—some resources are inherently unique or were originally acquired under nonreplicable conditions, such as a distinctive location, the cooptation of a sole raw material source, or first-mover advantages such as reputation, brand loyalty, or the power to establish industry standards; (3) *embeddedness of resources*—the value of a resource may be inextricably linked to the presence of another complementary or cospecialized resource; and (4) *causal ambiguity*—the connection between a firm's resource portfolio and its performance may be unclear, such as when a firm's success results from cultural or social phenomena too complex for managers to understand or manage (Lieberman and Montgomery, 1988; Dierickx and Cool, 1989; Barney, 1991).

Whereas traditional strategy research has focused on advantages derived from industry and competitive positioning, the resource-based research has focused on advantages stemming from firm-specific, intangible resources such as organization culture, learning, and capabilities (Hall, 1993). Firm specificity (e.g., skills developed to operate highly specialized machinery) enables firms to capture returns to a valuable resource by reducing its value in other contexts, and intangibility raises impediments to competitive observation and interpretation. Unlike product attributes and strategic positions, which competitors often replicate, or render obsolete, firm-specific, intangible resources tend to be tacit, idiosyncratic, and deeply embedded in the organization's social fabric and history (Winter, 1987). Protected by isolating mechanisms such as resource connectedness and causal ambiguity, these resources may offer more complex and sustainable paths to competitive advantage (Hansen and Wernerfelt, 1989; Rumelt, 1991; Powell, 1996).

Do ITs meet resource-based criteria for sustained competitive advantage? In a resource-based conceptual analysis of ITs and firm performance, Clemons and Row advanced a commodity view of IT, arguing that competitive imitation eventually erodes most IT-based advantages, that non-imitators are eliminated, and that above-normal returns to the IT eventually vanish. The authors also argued that, not only are ITs unlikely to differentiate competitive performance, but they may not even improve overall industry returns, since customers and suppliers may coopt any potential efficiency gains for themselves. The authors concluded that 'Examples of using information technology to achieve sustainable advantage through either barriers to imitation or first mover advantages do exist, but they are far less common than a trusting first scan of the MIS literature would imply' (1991: 278).

The notion that ITs *per se* do not generate sustainable performance advantages has received increasing support in recent IT research, and has produced a perspective known as the 'strategic necessity hypothesis,' to which most IT researchers now adhere (Clemons, 1988; Floyd and Wooldridge, 1990; Clemons and Row, 1991; Kettinger *et al.*, 1994). This hypothesis consists of two propositions: (1) ITs provide value to the firm by increasing internal and external coordinating efficiencies, and firms that do not adopt them will have higher cost structures and therefore competitive disadvantage; and (2) notwithstanding (1), firms cannot expect ITs to produce sustainable advantages because most ITs are readily available to all firms—competitors, buyers, suppliers, and potential new entrants—in competitive factor markets.

The strategic necessity hypothesis is somewhat bleaker than earlier perspectives in its estimate of the sustainability of IT-derived performance advantages, treating IT decisions more as threats than opportunities, i.e., as investments to avoid competitive decline, but with little likelihood of producing sustainable advantages. According to this view, firms would appear to have only three feasible paths to IT-based competitive advantage: either (1) reinvent IT advantages perpetually through continuous, leading-edge IT innovation; or (2) move first and erect inassailable first-mover advantages; or (3) embed ITs in organizations in such a way as to produce valuable, sustainable resource complementarity. The first two paths have proven precarious. Perpetual innovation may hypothetically produce advantages, but these advantages vanish if innovation either ceases or stumbles, and are haunted by ever-shortening IT development cycles. First-mover IT advantages seem more promising, particularly those—such as SABRE—involving proprietary systems customized to exploit firm-specific strengths or opportunities. However, such systems typically resolve into resource complementarities (i.e., they produce advantage by merging with skills, relationships, or strategic positions), and even then the empirical data (e.g., Kettinger *et al.*, 1994) suggest that such advantages rarely endure. For these reasons, the resource view has focused on resource complementarity as the most feasible path to IT advantage.

Despite its less optimistic view of IT's direct performance impacts, the strategic necessity hypothesis does appear to fit the emerging empirical evidence, and its resource-based origins provide a solid theoretical foundation for investigating the contexts and conditions under which IT may produce competitive advantage. Particularly, it points toward a more balanced perspective, one that acknowledges the commodity view, while allowing the possibility of advantages arising from merging ITs with other resources: if ITs *per se* do not provide distinctive advantages, then firms must use them to leverage or exploit firm-specific, intangible resources such as organizational leadership, culture, and business processes (Clemons and Row, 1991; Henderson and Venkatraman, 1993). The following section explores these notions further and develops hypotheses for empirical testing.

THEORY AND HYPOTHESES

In its treatment of IT-based advantages, the resource-based view has emphasized sustainability protected by resource embeddedness, i.e., resource complementarity and cospecialization. Complementarity represents an enhancement of resource value, and arises when a resource produces greater returns in the presence of another resource than it does alone, e.g., an electronic data interchange (EDI) system that only marginally improves performance under ordinary conditions, but produces sustainable advantages when combined with preexisting supplier trust. Complementary resources are cospecialized if one resource has little or no value without the other (Clemons and Row, 1991), e.g., IT hardware and software, neither of which has value without the other. Under the resource view, a complementary interaction typically enhances the value for both (or all) compementary resources, although the causality may be ambiguous (Barney, 1991). For example, an EDI system may enable a firm to enhance its supplier relationships, while the preexisting supplier relationships maximize EDI's inherent information-sharing capabilities. An off-the-shelf EDI system would be a commodity resource, yet it may combine with supplier trust to produce an embedded, mutually reinforcing, advantage-producing resource bundle.

Walton (1989) and Benjamin and Levinson (1993) classified resources as Organizational, Business, and Technological, and argued that IT performance depends on the integration of resources across these categories. Keen (1993) divided resources into Human, Business, and Technology resources, and developed a 'fusion' framework that strongly parallels resource-based theory, arguing that the key to IT success lies in the capacity of organizations to fuse IT with latent, difficult-to-imitate, firm-specific advantages embodied in existing Human and Business resources. A variety of alternative resource typologies exist (e.g., Grant, 1991; Barney, 1991; Black and Boal, 1994), but the Walton and Keen typologies arose specifically in the IT context, and focused on resources that may interact with IT to produce sustainable advantages. For example, Keen identified resources such as CEO commitment to IT, IT planning, and process redesign, and, using the Walton framework, Benjamin and Levinson (1993) focused on the role of organizational flexibility in successful IT implementation.

According to Keen, 'The wide difference in competitive and economic benefits that companies gain from information technology rests on a management difference and not a technical difference. Some business leaders are somewhat better able to fit the pieces together than others' (1993: 17). The IT literature, contingency approaches, the strategic necessity hypothesis, and resource-based theory point to the same conclusion: that IT advantage depends heavily on 'fitting the pieces together,' i.e., on exploiting relationships among complementary organizational resources. In the following sections, we investigate Human and Business resources that may combine with ITs to produce competitive advantage through resource complementarity. These resources form the basis for our hypotheses and empirical test.

Complementary Human resources

Reed and DeFillippi (1990) and Fiol (1991) argued that organizational cultures offer powerful forms of competitive advantage because they are difficult to articulate and require the simultaneous manipulation of complex relationships and technologies. In resource-based empirical studies, Hansen and Wernerfelt (1989) found that human resource factors (i.e., organizational climate and goal directedness) explained greater proportions of performance variance than strategy and economic factors, and Powell (1995) found that behavioral factors, such as open culture and CEO commitment, explained significantly greater TQM performance variances than process factors (such as defect reduction) and traditional quality control methodologies. In the IT literature, Neo (1988) concluded that interactions among IT and qualitative organizational variables strongly influenced IT performance, Ginsberg and Venkatraman (1992) cited linkages among IT performance and CEO attributes, and a variety of practitioner-directed studies have prescribed IT complementarities with employee participation, empowerment, and cultural openness (e.g., Broderick and Boudreau, 1992; Pfeffer, 1995; Davenport, 1994).

Though currently popular, the notion that firms should merge technology with human dimensions is not new, tracing its roots to the 'sociotechnical' framework developed at London's Tavistock

Institute over 40 years ago (e.g., Trist and Bamforth, 1951; Rice, 1958; Emery and Trist, 1965). Based on earlier empirical studies, Miller and Rice (1967) developed the 'sociotechnical' framework as a reconciliation of human, organizational, and technological needs, arguing that maximized technological performance requires simultaneous optimization of an organization's social and technological subsystems. Subsequently, leading organizational researchers working in the 1960s and 1970s (e.g., Woodward, 1965; Child and Mansfield, 1972; Perrow, 1970) showed that technologies performed poorly in the absence of proper alignments with structures and cultures, conclusions that have received consistent support throughout the so-called 'human relations' (e.g., Roethlisberger and Dickson, 1939; McGregor, 1960) and 'contingency' (e.g., Lawrence and Lorsch, 1967) schools, as well as in more recent research linking organizations and technology (e.g., Huber, 1990; Orlikowski and Gash, 1992).

In this section we discuss relationships between IT and six potential complementary resources: open organization, open communications, organizational consensus, CEO commitment, organizational flexibility, and IT–strategy integration. The cultural variables most frequently linked with IT performance are *open organization* and *open communications*. Zuboff (1988), for example, argued that the benefits of ITs lay in their capacities to release information throughout an organization, and that artificial cultural or structural constrictions negate their value. As such, the author urged firms to embrace an open philosophy, allowing employees access to operating information traditionally controlled by upper management, and repudiating traditional hierarchies, top-down communications, and autocratic command and control. According to Zuboff, the 'informated' organization must operate lean, retraining or eliminating middle managers, and fostering frequent, unstructured communications across functional and project boundaries. Ultimately, executives must change from controlling authority figures to supporting counselors, relinquishing authority to those best positioned to make timely, informed decisions.

Although new ITs require extensive adaptations from managers, users, and technologists, firms often respond sluggishly, unable to execute the higher-order changes necessary to merge IT with patterns of interpersonal behaviors and communications (Orlikowski and Gash, 1992). Zuboff suggested that ITs often fail because managers underestimate the magnitude of the required organizational shifts, as well as their own resistance to implementing the principles of open organization. Empirical results in the organizational ecology literature have shown that innovations affecting core organizational features (such as structures and cultures) produce the most powerful resistance to adoption because managers perceive them as posing the most significant survival risks (Hannan and Freeman, 1984; Singh, Tucker, and House, 1986). In resource terms, managerial resistance to open organization acts as an isolating mechanism that impedes successful IT imitation, and protects the performance advantages of firms that combine IT with open cultures.

The IT research also suggests that complementarities may exist between ITs and *organizational consensus*, i.e., organizational trust, cooperation, and the absence of fundamental conflict. In an empirical study of 168 Belgian firms, DeWoot, Heyvaert, and Martou (1978) found that financial performance was not explained by technical innovations themselves, but rather by innovation processes that involved little irrelevant disagreement and an attempt to integrate technology with strategy. Rockart and Short (1989) argued that ITs increase mutual dependencies across organizational functions, enabling more frequent and elaborate communications among disparate interests, and requiring personnel to interact more 'seamlessly.' In a retail industry analysis, Clemons and Row (1993) argued that new retail ITs require stores to interact more cooperatively with their own home offices and distribution centers, as well as with suppliers connected through EDI systems. And in her large-scale innovation study, Kanter concluded that the most effective innovators 'reduce rancorous conflict and isolation between organizational units; create mechanisms for exchange of information and new ideas across organizational boundaries; ensure that multiple perspectives will be taken into account in decisions; and provide coherence and direction to the whole organization. In these team-oriented cooperative environments, innovation flourishes' (1984: 55).

Although researchers have extensively investigated the role of consensus in strategic planning and firm performance (e.g., Bourgeois, 1980; Hrebeniak and Joyce, 1984; Dess, 1983, 1987; Dess and Origer, 1987), the evidence has not shown conclusively that consensus alone has intrinsic value to the organization. Bourgeois (1980) and Hrebeniak and Joyce (1984) did find connections between performance and top management consensus on strategy, but Dess (1987) concluded only that consensus on either strategies or objectives was necessary, and in the Bourgeois study performance did not correlate with consensus on objectives. On the other hand, intraorganizational conflicts affect not only top management, but entire organizations, and even small conflicts can embed themselves deeply and intractably, misdirecting motivation, decreasing adaptability and inhibiting the productivity of people and technology (Walton and Dutton, 1969). Whereas organizational consensus reinforces IT's capabilities to expand communications and disseminate information, functional area conflicts and territorialism thwart them, and inhibit IT functionality (McCann and Galbraith, 1981; Kanter, 1984). Conversely, ITs may enhance the value of a high-consensus culture, facilitating communications and mutual interdependencies (Rockart and Short, 1989).

In describing linkages among IT, strategy, and organizational infrastructures, Henderson and Venkatraman (1993) emphasized the role of the *CEO commitment* to the success of IT implementation. According to the authors, successful IT requires a top executive who acts as 'business visionary' and 'prioritizer,' clearly supporting and articulating the need for IT, and communicating its functionality within the context of the organization's strategy, structure, and systems. Neo's (1988) analysis produced a similar result, the author reporting that 'management vision and support' differentiated successful from unsuccessful IT implementers. The same notion arises in Quinn's (1979) concept of 'top level risk-taking support,' in Maidique and Hayes' (1984) 'field general,' and in Benjamin *et al*.'s (1984) concept of the 'senior management entrepreneur' who is willing to view IT as a central part of business thinking, to examine how strategic decisions are affected by ITs, and to examine cross-functional IT applications.

CEO commitment enhances IT success by making resources available for implementation, integrating IT with business strategy and processes, and ensuring continuity in IT investments over time (Kettinger *et al*., 1994). The evidence suggests that many CEOs find ITs threatening, and that CEOs' verbalized commitments are frequently perceived as shallow, uninformed and unsupported by resource deployments (Kanter, 1984). In a study of IT systems in 24 companies, Benjamin *et al*. found that 'Only a handful of companies demonstrated that managerial attention was focused on the potential impact of information technology' (1984: 28), and CEOs have well-documented tendencies to perpetuate commitments to the status quo (Hambrick, Geletkanycz, and Fredrickson, 1993), and to develop successors who share their own repertoires and frames of reference (Smith and White, 1987). These CEO biases and rigidities may create inadequate or inconsistent IT deployments, and combine with IT obsolescence to inhibit performance.

According to Benjamin and Levinson (1993), IT change processes affect every function and organizational stakeholder, and therefore require fluidity of coordination, or *organizational flexibility*. If ITs require significant alterations in organizational structures (Barley, 1990), communication patterns (Huber, 1990), and power relations (Pettigrew, 1973), then first-order change—i.e., incremental modification of existing behaviors—is inadequate. Nonetheless, inertial forces protect the status quo, often making even first-order change unattainable (Bartunek and Moch, 1987). Orlikowski and Gash assert that ITs typically require second-order change, i.e., 'a shift to radically different frames and processes, with the shift representing a replacement of the status quo' (1992: 8); and in the longer run require third-order change, i.e., the creation of a capability to change. According to Orlikowski and Gash, ITs require adaptations not only in the outward manifestations of IT, but in the frames and behavioral repertoires of managers, technologists and IT users.

IT researchers, consultants, and executives have universally asserted that firms should integrate IT with overall strategic planning efforts (e.g., Porter and Millar, 1985; Rackoff *et al*., 1985; Bakos and Treacy, 1986; Beath and Ives, 1986; Clemons and Row, 1991; Holland *et al*., 1992), and we therefore include *IT–strategy integration* as a potential advantage-producing complementarity. According to Clemons, 'The importance of selecting strategic opportunities, applications that are consistent with and support the firm's strategic objectives, requires real links between MIS and strategic planning. It also requires the ability to seek out, to find, and to recognize these strategic opportunities' (1986: 135). Rockart and Short (1989) made the additional point that not only does planning improve IT effectiveness, but IT may provide the systems and information that can make planning more effective, creating a symbiotic IT–planning relationship.

Complementary business resources

In this section we discuss the relationships among IT and six potential complementary business resources: supplier relationships, IT training, business process design, team orientation, benchmarking, and IT planning.

Keen (1993) argued that firms need to integrate technologies with business logistics and practices, including supplier logistics, business process design, and IT planning. *Supplier relationships* occupy a central role, particularly in light of the rapid expansion of electronic data interchange (EDI) technologies (Holland *et al*., 1992). EDI systems combine intra- and interorganizational information processing to facilitate sophisticated electronic interactions with suppliers. However, in the absence of open and trusting supplier relationships, such systems can do little but magnify existing suspicions, and fracture tenuous relationships (Johnston and Vitale, 1988; Holland *et al*., 1992). The capacity to craft and maintain trusting and economically viable supplier relationships, and then to leverage these relationships using sophsiticated interorganizational ITs, appears to require tacit, complex coordination and communications skills that competitors may find difficult to replicate (Winter, 1987; Hall, 1993).

IT researchers consistently advocate *IT training* as an indispensable complement to hardware and software investments (e.g., Kanter, 1984; Benjamin *et al*., 1984). On the other hand, IT training often has a commodity-like character, and generic IT training services are broadly available at a market price. As such, the only sustainable value to IT training appears to lie in merging firm-specific ITs with firm-specific training to produce idiosyncratic, causally ambiguous organizational capabilities (Barney, 1991). This may be possible through a combination of formal and on-the-job training methods, such as job rotation, cross-training, and mentoring (Landy, 1985), which emphasize firm-specific IT applications, and may in the long run produce embedded IT skills.

Keen's (1993) fusion model strongly emphasized the integration of IT with business processes, and Boar (1994) proposed a model aligning IT with *business process redesign*, i.e., the complete reevaluation of existing customer-driven business processes, such as order fulfillment and new product development, and integration of these processes with IT capabilities. This approach, better known as 'business process reengineering,' has been popularized by Hammer and Champy (1993), who suggested that implementing new ITs within traditional functionally driven structures is equivalent to 'paving the cow paths.' Process reengineering supporters argue that traditional functional structures camouflage value-creating processes, and that managers should focus not on ITs, but on business process redesign. According to Hammer and Champy (1993: 83), 'Technology is an *essential enabler* … Merely throwing computers at an existing business problem does not cause it to be reengineered. In fact, the *misuse* of technology can block reengineering altogether by reinforcing old ways of thinking and old behavior patterns.'

Boar argues that neither IT nor process redesign alone is sufficient, but that 'a state of alignment is mandated' (1994: 187). This state of alignment would appear to draw upon a variety of firm-specific capabilities and practices, involving an assessment of current structure and processes, diagnosis of IT requirements, and a fundamental realignment of structure and processes in conjunction with the introduction of new ITs. Not surprisingly, firms have experienced difficulty and disillusionment in implementing these dramatic realignments, and reengineering author and consultant Michael Hammer has estimated the reengineering failure rate at between 50 percent and 70 percent (Keidel, 1994). Of all the proposed complementarities, process reengineering appears to demand the most fundamental perspective shifts, while the complex, tacit, firm-specific nature of the integration of ITs and business processes may act as a significant impediment to competitive imitation.

Rockart and Short (1989) have argued that a powerful IT feature is its capacity for enabling people to work effectively in *teams*. If, as discussed earlier, ITs facilitate the move away from traditional hierarchy and toward open organization, what remains would appear to be the team-based structure (Jasinowski and Hamrin, 1995). According to Rockart and Short, ITs such as e-mail, voice-mail, computer conferencing, and videoconferencing make it more feasible for teams to coordinate asynchronously (across time zones) and geographically. Moreover, a growing body of increasingly sophisticated, user-friendly software products—such as 'groupware' and project management software—have enhanced team planning and communications capabilities. As network-based ITs become more widespread, organizational performance may become increasingly affected by organizations' capacities to manage the interaction of teams and ITs (Manz and Sims, 1993; Nolan and Croson, 1995).

Some researchers have argued that best-practices *benchmarking* is essential to the development of competitive IT systems (Boar, 1994; Hammer and Champy, 1993), and benchmarking advocates have claimed that 'benchmarking has emerged as a fundamental tool for helping managers better evaluate the features, functionality, benefits, roles and costs of technology' (Bogan and English, 1994: 171). However, as a sustainable source of competitive advantage benchmarking is inherently suspect, since it appears to emphasize the systematic observation and replication of competitive resources, rather than the design of firm-specific applications. A firm might very well extend its own innovative capacities by observing the processes and technologies of competitors (or firms in other industries), but it is not clear that firms consistently utilize benchmarking in that fashion, or that it would be reasonable to expect them to do so. We include benchmarking in our research because of its widespread practice (Whiteley, 1992) and its increasing presence in the IT literature, but we are aware of no empirical studies that have demonstrated a benchmarking–performance linkage.

Of the studies cited thus far, few have failed to advance systematic *IT planning* as the preferred alternative to erratic or unplanned development. Clemons (1986), for example, lamented that most of the spectacular successes were, in fact, accidents, with managers developing ITs as solutions to pressing problems, without recognizing their potential strategic impacts. Thus, American Airlines invited competitors to share in the development of an industrywide information system, viewing SABRE as a response to personnel shortages and the rising costs of order entry, not as an opportunity to manipulate industry structure. According to Clemons (1986: 132): 'Accidents make very good copy, but are a dreadful way to create business strategy.' On the other hand, the voluminous literature linking strategic planning and financial performance has produced equivocal results (see Miller and Cardinal, 1994), suggesting that planning alone does not readily convert to superior performance. According to Barney, a planning system may conceivably produce advantages, but only if it 'enables a firm to recognize and exploit other of its resources, and some of these resources might be sources of sustained competitive advantage' (1991: 113). Acknowledging its pervasiveness, we include IT planning in our research, noting that the advantage-producing opportunities for IT planning may be limited to cases of highly idiosyncratic, firm-specific IT planning processes.

Hypotheses

Based on the strategic necessity hypothesis, our *a priori* expectation is that Technology resources (ITs) behave as commodities, and therefore do not explain performance variance across firms. However, based on our review of complementary Human and Business resources, we would expect to find that certain Human and Business resources do combine with ITs to explain significant performance variance. Although the performance relationship seemed doubtful for some IT–Business complementarities—e.g., benchmarking and IT planning—for convenience we present our hypotheses in positive form, proposing generally that the Human and Business resources will produce the complementarities claimed for them. The Human and Business resources are summarized in Table 1, and our hypotheses are presented as follows:

> *Hypothesis 1: Human resources complementary to IT create embedded advantages that explain significant performance variance among firms.*

> *Hypothesis 2: Business resources complementary to IT create embedded advantages that explain significant performance variance among firms.*

> *Hypothesis 3: Technology (IT) resources do not explain significant performance variance among firms.*

Table 1. Human, business, and technology resources

Human resources
- Open organization
  A culture of trusting and open relationships with minimal formalization and bureaucracy
- Open communications
  Free oral and written communications within and across business units, chains of command, and functional boundaries
- Consensus
  Minimal conflict in goal-setting, decision-making and action-taking
- CEO commitment
  A clear and visible CEO commitment to IT
- Flexibility
  A culture that embraces and encourages change and experimentation, minimizes fear of failure, and welcomes opportunities to apply new IT developments
- IT/Strategy integration
  Integration of IT planning with the overall goals, strategies, and strategic planning processes of the firm. An attempt to fit IT into strategic objectives rather than adopt ITs for their own sake

Business resources
- Supplier relationships
  Open and trusting relationships with key suppliers
- Supplier-driven IT
  Encouragement and support by suppliers to adopt new ITs that may create interorganizational efficiencies
- IT training
  Personnel are well trained on existing applications, and IT training is a visible priority in the firm
- Process redesign
  An attempt to reevaluate and reorient traditional activities and structure along process lines, through 'business process reengineering' or other process-based methods
- Teams
  Conversion to a team-based structure, or the increased use of cross departmental teams in problem-solving
- Benchmarking
  Actively researching and observing best practices of other firms in activities or processes that need improvement
- IT Planning
  Clearly identified IT priorities and a plan for development and implementation

Technology resources
- ITs
  Computer hardware, software, and linkages (see Table 2 for retail-specific ITs)

DATA AND MEASURES

Sample

To test these hypotheses, the researchers sought a relatively low-technology industry that had undergone significant change as a result of identifiable ITs. We assumed that IT performance effects, if they existed, would most likely appear in an industry where, by common consent of experts and participants, the ITs had demonstrated profound strategic impacts. Moreover, to test the impacts of the complementary Human and Business resources, we required an industry where ITs had disseminated sufficiently for these resources to demonstrate their potential effects (e.g., we would not expect CEO commitment to IT to have significant performance effects in the absence of ITs). To isolate the effects of ITs, i.e., to eliminate entanglements with other product or process technologies, we rejected high-technology industries such as semiconductors and biotechnology.

After an extensive review of the academic, trade and popular journals, and discussions with experts and participants in a variety of industries, we chose to focus our study in the retail industry. Retail is the largest industry in the U.S.A., measured both by sales (roughly $500 billion annually) and total employment (over four million employees). Of the 15 largest employers in the

U.S.A., six—Wal-Mart, KMart, Sears, J. C. Penney, Kroger, and Dayton-Hudson—are retailers (*Fortune*, 1994). Nonetheless, retail has traditionally been a fragmented industry, consisting predominantly of single-unit local competitors with few if any technological capabilities, and little perceived need for them. Until the past 15 or 20 years, even many of the larger, national retailers operated with minimal technological capability and sophistication.

All this changed with the introduction of increasingly sophisticated point-of-sale (POS) scanning technologies, electronic data interchange (EDI) with suppliers, and computer-based systems for inventory management, administration, human resource management, communications, and marketing. Leveraging leading-edge technological breakthroughs, a few large retailers—most notably Wal-Mart and Toys R Us—revolutionized retail competition, establishing direct electronic linkages among stores, distribution centers, and suppliers, and redefining power relationships with suppliers and customers. Furthermore, retail ITs appear to be disseminating rapidly so that nearly all moderately large retailers have now implemented, at a minimum, the first-level POS scanning and inventory management technologies.

Wal-Mart took the industry lead in deploying POS scanning and EDI systems to decentralize buying and inventory decisions, and to establish direct, paperless linkages with manufacturers. In the 1980s, Wal-Mart invested in sophisticated POS scanners, equipped its distribution centers with laser-guided bar code readers, and bought its own satellite to transmit data across its network of stores, distribution centers, and suppliers. These systems, which cost Wal-Mart an estimated $700 million, have facilitated just-in-time replenishment and substantial annual savings through distribution efficiencies (Reid, 1995). In 1987, Wal-Mart also established its well-known partnership with Proctor & Gamble, which involved both data-sharing and active supplier involvement in stocking decisions (Zinn *et al*., 1993). Although most larger retailers have made significant advances in POS technologies, many still trail in these more advanced EDI technologies—as of 1993, for example, roughly 700 retailers had begun to use EDI for purchase orders, but only about half of those also used EDI for invoices (Clemons, 1993).

Figure 1 depicts the range of IT linkages among stores, home offices, distribution centers, and suppliers in the retail industry. EDI, for example, involves transactions between manufacturers, retail distribution centers, and retail stores, whereas store–home office communications involve ITs such as fax, e-mail, and satellite communications. Based on research and interviews, the researchers divided these retail IT applications into two broad categories: in-store ITs (i.e., those that help administer store operations, such as POS scanners, inventory management applications, and administrative applications); and beyond-store ITs (i.e., everything else, including ITs physically located in distribution centers or home offices, or that connect stores with suppliers, such as EDI). Table 2 describes the ITs that fall under these two categories.

The empirical research proceeded in three phases. In the first phase, the researchers reviewed the existing academic and popular literature, both in IT generally and in specific retail applications, and conducted on-site interviews with retail executives, industry experts, store managers, and retail suppliers. Initial Linkert-type measurement scales were then developed for the Human, Business, and Technology resources (shown earlier in Table 1), the latter consisting of the in-store and beyond-store ITs (shown in Table 2). These scales were then pretested and refined by administering the initial survey to small groups of retail executives and store managers, and by follow-up interviews concerning the scope, relevance, clarity, and form of the survey items. Cronbach reliabilities in the initial tests ranged between 0.50 and 0.90, and construct reliabilities appeared high based on variable intercorrelations and participant feedback. Participant suggestions resulted in minor modifications for form and clarity, ultimately producing the measures shown in Appendix 1.

In the second phase, a list of U.S. retailers was assembled based on 4-digit SIC code classifications, and on mailing list and firm size data provided in *Ward's Business Directory* (1994). Despite recent industry consolidation, retail remains relatively fragmented and the vast majority of retailers in the directory had fewer than 50 employees, and little IT development. As such, the researchers focused on larger retailers, while also attempting to secure broad representation across retail sectors. Although there were

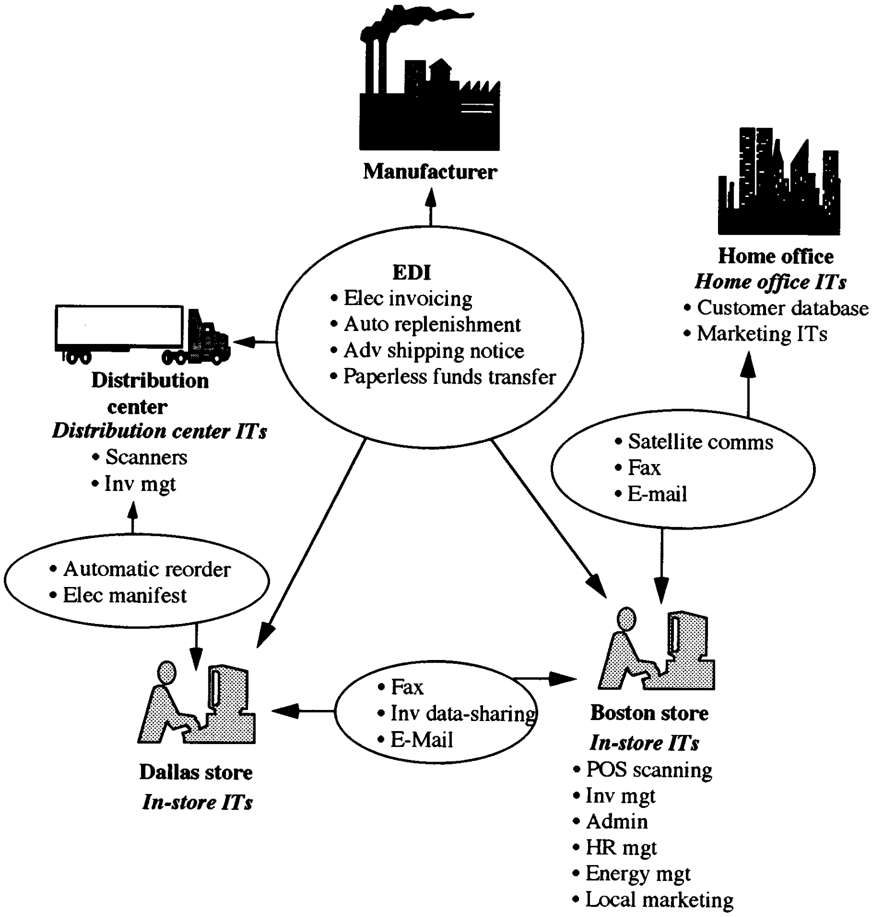

Figure 1. IT linkages in the retail industry

no hypotheses based on industry sector, 'specialty apparel' and 'other specialty retail' far outnumbered other sectors, and these sectors would have been underrepresented in a sampling based on firm size alone. Thus, the researchers divided 19 4-digit SIC codes into seven broad retail sectors—department stores, mass merchandisers, home improvement, supermarket, drug, specialty apparel, and other specialty retail (e.g., furniture stores, book stores, jewelry stores)—and sampled from large firms in each sector, even if they were not among the largest in the industry as a whole. Using the criteria of firm size and sector representation, 250 retailers were chosen for the initial mailing, and a survey was mailed to the CEOs of these firms.

Administration of the survey followed guidelines prescribed in Dillman (1978). Before the mailing, each of the 250 retailers was phoned to verify address, phone and the current CEO, and a follow-up postcard and two follow-up letters (with surveys) were sent to CEOs who did not respond to the initial mailing. The CEOs were asked to fill out the surveys personally if they had the information being requested but, if not, to ask their chief information officer or other senior executive to complete the survey. According to the names and titles provided on the surveys, all surveys had been completed either by CEOs or other senior executives.

Of the 250 surveys mailed, 67 were returned, 65 of which were complete, for a usable response rate of 26.0 percent. This compares with a 21 percent response rate reported by Powell (1992a), and 28 percent response rates reported in studies by Gomez-Mejia (1992) and Zahra and Covin (1993) using comparable survey methodologies. Moreover, mean firm sales and employees in the sample did not depart significantly from population sizes obtained from *Ward's Business Direc-*

Table 2. In-store and beyond-store information technologies

In-store ITs
- Scanning ITs
  Scanners that log the receipt of goods; scanners at the point of sale (POS) for recording purchases for accounting, marketing and inventory management purposes; scanners for taking physical inventories; handheld, portable scanning terminals
- Inventory management ITs
  System capacities for tracking month-to-date units sold for all SKUs; tracking current inventory for all SKUs; connectivity with central home office computer or data base; automatic reordering capability; electronic access to inventory data from other stores
- Administration
  Computer-generated sales forecasting; electronic bookkeeping and reporting
- Human resource administration
  Electronic labor planning and scheduling; electronic time clocks; electronic payroll; computer software and systems for training
- Energy management
  Automated systems to manage energy consumption such as climate and lighting
- Store communications
  Electronic mail among stores; in-store fax machines
- Marketing technology
  Automated direct mail or other in-store electronic marketing capability

Beyond-store ITs
- Home office/store communications
  Satellite communications between stores and home office; electronic mail between stores and home office
- Distribution center inventory management
  Scanners in the distribution center; automated inventory management at the distribution center
- Distribution center communications
  Automated reordering between stores and distribution center; electronic manifesting with distribution center
- Electronic data interchange (EDI)
  Scanner-driven automatic invoicing of suppliers; continuous replenishment of distribution centers or stores; advance shipping notice with suppliers; electronic or paperless funds transfer with suppliers
- Home office marketing
  Home office computer data base of customers; computer-aided preferred customer target marketing

tory, supporting the external validity of the sample. All seven industry sectors were represented, with ‘specialty apparel’ and ‘other specialty retail’ producing the largest response, consistent with their larger numbers in the population. As expected based on our use of firm size as a sampling criterion, the typical respondent was relatively large and well established: mean annual sales were $1.5 billion (median = $350 million), mean number of employees was 11,540 (median = 3000), mean number of retail stores per company was 533 (median = 130), and mean firm age was 46 years (median = 38 years).

In the third phase, the researchers prepared an abridged version of the original survey for administration to retail store managers in stores corresponding with the firms that had responded in the second phase. The measurement scales are shown in Appendix 2. The purposes of this survey were, by obtaining two independent responses for as many firms as possible, to mitigate the effects of single-respondent bias, to measure the inter-rater reliability of the scales, and to compare home office and store perceptions of IT implementation and performance. In order to facilitate comparisons with home office responses, the abridged survey contained, to the degree possible, the same items as the home office survey. The In-Store Technology questions were identical, as were the Human resource questions, with the four exceptions noted in Appendix 2. The IT/Strategy integration item was excluded from the Human resource section of the abridged survey, and the Business resource and Beyond-Store Technology sections were excluded in their entirety, since the questions did not generally fall within the direct experience of store managers.

In order to give the researchers additional insights and exposure to IT retail applications, an attempt was made, in conjunction with survey administration, to obtain personal, on-site interviews with as many store managers as possible. The researchers contacted retail store managers for those respondent firms that had store locations within approximately a 60-mile radius of the researchers' home institution, an area that included two large cities and numerous suburban shopping malls. Fifty of the 65 respondents had store locations in this area, and these store managers were contacted by phone, with a request for an on-site personal interview or, in the alternative, to complete the survey either by mail or fax. Of the 50 managers contacted, 43 agreed to participate, and these managers completed the abridged survey. Of these 43, 22 were interviewed on-site.

Measures

As described above, measures for the variables comprising Human, Business, and Technology resources were developed through literature reviews and interviews in the first phase, and were subsequently refined in pretesting. All measures are provided in Appendices 1 and 2. Two performance measures were used as dependent variables in the study: IT Performance and Financial Performance. IT Performance consisted of five survey items (shown in the first part of Appendix 1E) designed to measure executives' perceptions about the impacts of IT on financial performance. Financial Performance (shown in the second part of Appendix 1E) was designed as a subjective measure of financial performance itself, consisting of questions about the firms' overall profitability and sales growth over the previous 3-year period. The two scales were placed in separate parts of the survey to mitigate potential autocorrelation effects. Internal Cronbach alphas for the IT and Financial Performance measures were quite high ($\alpha = 0.92$ and 0.94, respectively), but the variables did not correlate significantly with one another ($r = 0.16$), suggesting that autocorrelation was minimized.

In using subjective performance measures, the researchers assumed, given the senior executives involved, that respondents had sufficient perspective and information to assess their firms' performance relative to competitors. Subjective measures have been widely used in organizational research (Lawrence and Lorsch, 1967; Dess, 1987; Powell, 1992a), and are often preferred to financial statement data, since firms may adopt varying accounting conventions in areas such as inventory valuation, depreciation, and officers' salaries. Also, this research included many privately held firms that would not have provided confidential financial information as a matter of policy. However, as a test of the convergent validity of the Financial Performance measure, accounting performance measures were obtained for 20 publicly held survey participants for the same 3-year period covered by the subjective survey items. In this subsample, return on sales, a commonly used measure of financial performance in strategy research (e.g., Cool and Dierickx, 1993; Zahra and Covin, 1993), correlated significantly with the subjectively derived Financial Performance measure ($r = 0.58$; $p \leqslant 0.01$), suggesting that, although the accounting and subjective measures were not identical, the accounting measures did constitute a key element of the respondents' subjective assessments.

As shown in Appendix 1, all variables were measured using Likert-type scales comprised of between one and six items, depending on the complexity or multidimensionality of the variables. Whenever possible, Cronbach's alpha was computed as a measure of scale reliabilities (Cronbach, 1951). Although no precise ranges exist to evaluate Cronbach's alpha, Van de Ven and Ferry (1979) recommended a minimum of 0.35, with appropriate ranges depending on the breadth and complexity of the variable. In the home office results, the alphas ranged between 0.71 and 0.92 for the Human variables, between 0.71 and 0.83 for the Business variables, and between 0.60 and 0.89 for the Technology variables. For the store data, the coefficients ranged between 0.72 and 0.92 for the Human variables, and between 0.54 and 0.78 for the Technology variables (the Business variables were not measured in the store surveys). Overall, the mean alpha for the home office survey scales was 0.77 and for the store survey scales was 0.76, and the coefficients tended to support both the reliability of the scales and their robustness across different sampling contexts.

It was possible to measure the interrater reliability of the Human, Technology, and Performance scales by comparing home office responses with those obtained from store managers. For the 29 survey items that appeared in identical form on the 43 matching home office and store surveys, the average overall correlation between home office and store responses was $r = 0.54$ ($p \leqslant 0.001$), and ranged as high as $r = 0.75$ for some variables, compared with an expected value of zero if the surveys had been matched randomly. The highly significant correlations supported the interrater reliability of the survey scales, but also showed that some differences remained between store managers' and home office executives' perceptions of the variables examined in this study. Although this is probably to be expected given their different geographical locations and managerial perspectives, the researchers speculated that the differences might also reflect communication or conflict problems in the firms. Since intrafirm communication and consensus pertained to our research objectives, we examined this possibility when comparing home office and store results, and will return to this issue in the following section.

DATA ANALYSIS AND FINDINGS

We estimated the following linear regression model:

$$Z_Y = \beta_H Z_H + \beta_B Z_B + \beta_T Z_T$$

where Z_Y is a standardized Performance measure, H is the variable set of Human resource variables, B the set of Business variables, T the set of Technology variables, β_X the standardized partial regression coefficients for estimating Z_Y from variable X, and Z_X the standardized measure for variable set X. Our hypotheses predict that coefficients β_H and β_B (i.e., the Human and Business variable sets) will be positive and significant, but that coefficient β_T (i.e., the Technology variable set) will not depart significantly from zero.

Appendix 3 provides an overall correlation matrix for 29 variables measured in the home office segment of the study, i.e., the 25 independent variables in the three variable sets, plus firm size (using the natural logarithm of the number of employees), firm age, and the two performance dependent variables. Table 3 summarizes the data according to variable sets, and provides descriptive statistics and correlations with both performance measures.

Table 3 shows that all three variable sets correlated significantly with IT Performance, the measure of executives' perceptions of IT performance in their firms. The data show that retail executives attributed IT success in almost equal portions to Human (overall $r = 0.47$), Business ($r = 0.44$), and Technology ($r = 0.36$) resources. For Overall Performance, the table shows a somewhat different result, with a positive and significant zero-order correlation with Human resources ($r = 0.45$), a moderate correlation with Business resources ($r = 0.23$), and a negative but non-significant correlation with Technology resources ($r = -0.05$). In other words, even though retail executives attributed IT success to the three variable sets in more or less equal proportions, the data show no zero-order correlation between ITs and overall firm performance.

Table 4 presents the results from the multiple regressions for the three variable sets both for IT Performance and Overall Performance. Results are also given for Profitability and Sales Growth, which were subsets (items three through five) of the Overall Performance scale shown in Appendix 1E. Ln emps was included in the regression as a control for firm size effects. Table 3 shows that the variables combined to explain 34 percent of IT Performance variance, and an estimated 29 percent of variance in the population (using adjusted R^2, which estimates population effects based on sample degrees of freedom). For Overall Performance, the variables explained 22 percent of variance in the sample, and an estimated 17 percent of variance in the population.

The results in Table 4 tend to support Hypothesis 3, i.e., that ITs do not, in and of themselves, explain significant overall financial performance among firms. The standardized regression coefficients were negative for each of the three Overall Performance measures, though not significant. The data also tend to support Hypothesis 1:—i.e., that Human complementary resources account for significant Overall Performance variance—with the Human resource set yielding large positive coefficients for all performance measures. The Human resource effect was sufficiently powerful, in fact, to eliminate the zero-order performance effects of the Business resource set, so that Hypothesis 2 was not supported in the data.

To explore these findings further, the researchers ranked all 65 firms on the overall IT variable scores and divided them at the midpoint

Table 3. Descriptive statistics and performance correlations: Home office data

				Performance correlations	
($N = 65$)	α	Mean	S.D.	IT Perf	Overall Perf
Human resources					
Open org	0.71	3.52	0.76	0.40***	0.33**
Open comms	0.85	3.53	0.84	0.46***	0.44***
Consensus	0.82	3.73	0.89	0.32**	0.36**
CEO commit	0.92	3.94	0.95	0.33**	0.28*
Flex	0.85	3.30	0.80	0.37**	0.25*
IT/Strat	na	3.54	1.20	0.22†	0.29*
Overall Human resources	0.82	3.59	0.91	0.47***	0.45***
Business resources					
Supplier rels	na	3.51	0.87	0.26**	0.20
Supplier driv	na	2.75	0.97	0.08	0.11
Train	0.77	3.16	0.71	0.50***	0.26**
Process	0.83	3.49	0.94	0.00	0.01
Teams	na	3.72	0.96	0.39**	0.22†
Benchmark	na	3.55	0.92	0.46***	0.05
IT Planning	0.72	3.32	0.80	0.21†	0.18
Overall Business resources	0.71	3.36	0.88	0.44***	0.23†
Technology resources					
In-store ITs	0.67	2.75	1.06	0.21†	−0.04
Scanning	0.81	3.07	1.20	0.29*	−0.10
Inv mgt	0.65	2.89	1.29	0.42***	0.10
Admin	0.69	2.25	1.07	0.28**	0.07
HR admin	na	1.46	1.53	0.20	0.01
Energy	na	2.36	1.43	0.08	−0.14
Store comms	na	1.37	1.51	0.17	−0.05
Marketing	0.75	2.31	1.30	0.37***	−0.04
Overall In-store					
Beyond-store ITs					
HO/Store comms	na	1.91	1.26	0.21†	−0.17
DC inv mgt	na	2.36	1.35	0.34***	−0.07
DC comms	0.60	2.32	1.35	0.16	0.03
EDI	0.81	1.51	0.94	0.17	−0.03
HO mktg	0.89	2.06	1.46	0.02	0.01
Overall Beyond-store	0.66	2.03	1.31	0.28	−0.06
Overall Tech resources	0.79	2.19	1.30	0.36***	−0.05
Performance					
IT Perf	0.92	3.61	0.80	1.00	0.16
Overall Perf	0.94	3.38	0.96	0.16	1.00

Notes
'na' refers either to single-item measurement scales, or additive scales for which Cronbach coefficients would be inappropriate reliability measures (see Appendices 1 and 2).

Overall variables are linear combinations of variables in their respective categories.

Key to significance tests (two-tailed)
†$p \leqslant 0.010$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$

Table 4. Multiple regressions and hypothesis testing

($N = 65$)	Dependent variables IT Perf β	Overall Perf β	Profitability β	Sales Growth β
Human resources	0.33**	0.52***	0.42**	0.52***
Business resources	0.17	–0.08	–0.08	–0.12
Technology resources	0.30*	–0.12	–0.18	–0.10
ln emps	–0.06	0.09	0.17	0.06
R	0.58***	0.47**	0.40**	0.46**
R^2	0.34	0.22	0.16	0.21
R^2, adjusted	0.29	0.17	0.11	0.16

Key to significance tests
†$p \leqslant 0.10$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$

into two subsamples, labeled IT-Intensive ($n = 32$) and IT-Lagging ($n = 33$) firms. Table 5 compares descriptive statistics and correlations for these two subsamples. The data suggest that IT intensity in the retail industry is driven primarily by firm size, as measured by number of employees and annual sales, though not by dispersion (i.e., size as measured by number of stores or number of geographic regions in which they compete). The data also suggest that IT-intensive firms tend to employ the Business complementary resources more intensively, but not the Human resources. The executives of IT-Intensive firms rated their IT performance significantly higher than those of IT-Lagging firms, but the IT-Lagging firms performed slightly better overall than the IT-Intensive firms (though not significantly so), consistent with the small, negative IT–Overall Performance correlation shown earlier in Table 3.

Table 5 provides additional evidence that ITs can produce competitive advantage by leveraging or exploiting Human and Business resources. Whereas Table 3 had shown a large and highly significant zero-order correlation between the Human resource set and Overall Performance, Table 5 shows that this correlation disguised two different effects: a non-significant (though positive) effect for IT-Lagging firms ($r = 0.24$), and a highly significant effect for IT-Intensive firms ($r = 0.57$, $p \leqslant 0.001$). Similarly, the moderately significant zero-order correlation between Overall Performance and the Business set in Table 3 ($r = 0.23$) had disguised the offsetting effects of a nonsignificant correlation among IT-Lagging firms ($r = 0.10$) and a significant correlation among IT-Intense firms ($r = 0.50$; $p \leqslant 0.01$). With the Human and Business resources yielding their highest returns in IT-intensive firms, these results suggest that ITs do have the capacity to leverage preexisting intangible resources. On the other hand, the lack of significant overall performance differences between IT-Intensive and IT-Lagging firms suggests that many IT-Intensive retailers have not merged these resources successfully.

As a supporting hypothesis test, the researchers analyzed a subsample of 26 specialty apparel retailers. Although all 65 firms in the full sample competed in retail, aggregation across heterogeneous retail sectors may have disguised within-sector effects. Of the seven original retail categories sampled, specialty apparel contained by far the largest number of firms, and correspondingly produced the largest responding subsample (and the only sector subsample large enough to support independent analysis). Descriptive statistics and standardized regression coefficients for the specialty apparel subsample are shown in Table 6, and tend to support the results in the overall sample—the means did not differ significantly from those presented in Table 3, and the significance tests for the standardized regression coefficients closely paralleled those in Table 4.

Appendix 4 provides a correlation matrix for 12 variables measured in the store manager phase of the study—i.e., five Human resource variables and seven Technology (IT) variables—and Table 7 summarizes the data, providing descriptive statistics and correlations between the store

Table 5. IT-intensive and IT-lagging firms

	Descriptive statistics				
	IT-intensive firms ($n = 32$)		IT-lagging firms ($n = 33$)		
	Mean	S.D.	Mean	S.D.	Δ
Firm employees	18,555.2	34,666.6	4,734.1	7,447.5	*
Sales	2,269.2	4,386.0	841.7	1,508.4	+
No. of stores	545.5	848.5	521.9	1,105.2	ns
No. of regions	4.3	2.7	3.4	2.4	ns
Firm age	48.4	33.6	43.6	40.5	ns
Overall Human resources	3.64	0.74	3.58	0.58	ns
Overall Business resources	3.54	0.56	3.23	0.52	*
Overall Technology resources	2.91	0.46	1.72	0.45	***
IT Perf	3.83	0.69	3.41	0.86	*
Overall Perf	3.27	1.02	3.48	0.90	ns

	Correlations with performance		
	IT-intensive firms r	IT-lagging firms r	Δ
r with IT Perf			
Human resources	0.59***	0.41*	ns
Business resources	0.61***	0.18	*
r with Overall Perf			
Human resources	0.57***	0.24	†
Business resources	0.50***	0.10	†

Notes
Significance tests for differences between r coefficients were computed using Fisher's r to z transformation and a normal curve test.

Key to significance tests
†$p \leqslant 0.10$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$

Table 6. Specialty apparel subsample data

			Dependent variables		
($N = 26$)	Mean	S.D.	Overall Perf β	Profitability β	Sales growth β
Human resources	3.68	0.51	0.65**	0.50**	0.65***
Business resources	3.35	0.47	0.03	0.13	0.01
Technology resources	2.08	0.79	–0.05	–0.08	–0.13
ln emps			–0.04	0.03	0.00
R			0.66**	0.57**	0.65**
R^2			0.43	0.32	0.43
R^2, adjusted			0.32	0.19	0.33

Key to significance tests
†$p \leqslant 0.10$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$.

Table 7. Descriptive statistics and performance correlations: Store data

				Performance correlations	
($N = 43$)	α	Mean	S.D.	IT Perf	Overall Perf
Human resources					
Open org	0.72	3.54	0.85	0.23	0.27†
Open comms	0.73	3.83	0.93	0.35*	0.40**
Consensus	0.92	4.14	0.85	0.31*	0.34*
CEO commit	0.90	3.58	1.07	0.35*	0.06*
Flex	0.85	3.65	0.92	0.23	0.39**
Overall Human res	0.82	3.79	0.90	0.28†	0.42**
Technology resources (In-store ITs)					
Scanning	0.78	2.34	1.39	0.05	–0.17
Inv mgt	0.63	3.16	1.00	0.16	–0.16
Admin	0.54	2.51	1.46	0.09	–0.13
HR admin	0.77	2.14	1.25	0.09	–0.06
Energy	na	2.14	1.77	0.15	–0.28†
Store comms	na	2.06	1.40	0.10	–0.21
Marketing	na	1.81	1.74	0.22	–0.24
Overall Tech res	0.79	2.19	1.35	0.01	–0.28†

Note
Overall variables are linear combinations of variables in their respective categories.

Key to significance tests (two-tailed)
†$p \leqslant 0.10$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$

manager independent variables and the performance dependent variables obtained in the home office surveys. Table 8 provides multiple regressions for the Human and Technology resource data obtained from store managers.

In Table 7, none of the means obtained in the store surveys differ significantly from those obtained from home office executives, and the performance correlations tend to corroborate the earlier conclusions. The store managers' assessments of Human resources correlated positively and significantly with Overall Performance ($r = 0.42$; $p \leqslant 0.01$), as compared with $r = 0.45$ ($p \leqslant 0.001$) in the home office data reported in Table 3. The In-Store Technology variables correlated negatively ($r = -0.28$; $p \leqslant 0.10$) with Overall Performance in store manager surveys, compared with $r = -0.04$ in the home office surveys. These results are corroborated in Table 8, and appear to provide support for the earlier hypothesis tests, particularly considering that the store responses were obtained at significant physical and perceptual distances from the home office performance data with which they correlate.

Table 8. Multiple regressions for store data

	Dependent variables	
($N = 43$)	IT Perf β	Overall Perf β
Human resources	0.39*	0.53**
Technology resources	0.04	–0.39*
No. of store employees	0.07	0.04
R	0.41*	0.51**
R^2	0.17	0.26
R^2, adjusted	0.10	0.20

Key to significance tests
†$p \leqslant 0.10$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$

Though the store data support the home office conclusions, the differences are also interesting, and deserve comment. Most obvious is the moderately large, negative Technology–Performance correlation in the store data. Since store managers work directly with the in-store ITs, one might assume that their responses are at least as accurate as those obtained from home office executives, and possibly more accurate. As such, one might reasonably conclude that, from the perspective of store managers, retail ITs simply do not produce the expected in-store performance gains. Merging the statistical results with anecdotal data, one might even conclude that, on the whole, store managers regard ITs as intrusive. To the extent that ITs have been successful, it appears from the IT Performance data in Table 8 that store managers attribute that success more to Human complementary resources ($\beta = 0.35$) than to Technology ($\beta = 0.07$), whereas home office executives attribute IT successes to both (see Table 4). Again, the responses reflect differences in perspectives, with store managers emphasizing the contributions of people who work with in-store ITs on a daily basis, and home office executives placing equal emphasis on ITs.

In another revealing difference, the home office responses produced a significant correlation between Overall Performance and CEO commitment to IT ($r = 0.28$; $p \leqslant 0.05$), but the store managers' responses did not ($r = 0.06$). This, perhaps, should not surprise us in light of the negative IT–Performance correlations at the store level—if ITs correlate negatively with performance, then commitment to them will not improve performance. Of all the variables in the Human resource set, CEO commitment is perhaps least likely to provide value to the firm independent of IT, and this is reflected in the store managers' responses. Moreover, field managers may generally find themselves less inclined than their home office colleagues to attribute firm success to CEO attributes.

In both the home office and store manager data, the communication and consensus variables correlated significantly with all performance measures. This led the researchers to speculate, as an additional measure of consensus effects, that overall performance might correlate with the magnitude of differences between the responses of the home office executives and their corresponding store managers. To test this notion, the researchers computed the squared differences between the home office and store responses on the overall Human resource and Technology resource sets, and correlated those difference scores with Overall Performance. The result was that Overall Performance correlated $r = -0.23$ ($p \leqslant 0.10$) with the Human resource difference score, and $r = -0.31$ ($p \leqslant 0.05$) with the Technology resource difference score. In other words, the greater the difference in intrafirm assessment of resources, especially the IT resources, the worse the performance of the firm. This result suggests that conflicting perceptions of Human and IT resources negatively impact performance, and again supports the notion that complementary Human resources such as communication and consensus play a vital role in the successful implementation of IT.

DISCUSSION

The resource-based view asserts that firms gain performance advantages by accumulating economically valuable, relatively scarce, and imperfectly imitable resources or resource combinations (Barney, 1986a, 1986b). Are ITs economically valuable? Toward the end of the 1980s, a decade in which U.S. firms invested over a trillion dollars in information technology, some economists spoke of a 'productivity paradox': despite the huge IT investments, over 85 percent of which were in service industries, both profits and productivity stagnated (Roach, 1991). Overall U.S. productivity rose at an average annual rate of 1 percent, compared with nearly 5 percent in Japan, and some speculated that IT overinvestment had contributed to the problem (Gleckman *et al*., 1993). In retail, productivity (i.e., average output per hour) rose at an average annual rate of 1.1 percent between 1973 and 1989, compared with 2.4 percent in the preceding 25-year period (Quinn and Baily, 1994).

IT proponents argue that it takes time, and a critical mass of investment, for ITs to yield benefits, and some suggest that 1990s growth figures prove these benefits are finally being realized. They also argue that productivity measures ignore what would have happened without IT investments—productivity gains might have been even lower in the 1980s, and entire new industries would not have existed, including computer software and satellite services (Quinn and Baily, 1994). Moreover, they claim that productivity gains disguise themselves, passing from services to manufacturing, as in the case of McKesson Drug, which has seen margins fall from 7 percent to 3 percent since implementing its pharmacy systems, but whose ITs improved productivity both for pharmacists and for drug manufacturers. According to Quinn and Baily (1994: 31), 'there is little doubt that IT has improved the performance of the service sector significantly, although macroeconomic measures of productivity may not reflect the improvement.' Even economist Stephen Roach, who originally proposed the 'economic paradox,' believes IT can now drive genuine productivity gains (Magnet, 1993).

But if we stipulate that ITs confer economic value, why do they not produce direct competitive advantages for firms? Our findings suggest two answers. First, we support the general consensus that ITs have become pervasive and relatively easy to acquire in competitive factor markets. Although retail systems varied greatly in their specifications, and some were far more advanced than others, all larger retailers had committed at some level to the basic scanning technologies. Second, our data suggest that most retailers have not merged IT with the requisite Human and Business complementary resources. The Human complementary resources, in and of themselves, explained performance differences in retail, as did, to a far lesser degree, the Business resources. IT did not. From this we conclude that, although the industry has invested sufficiently in ITs to negate direct IT advantages, some firms gained IT-related advantages by merging IT with complementary resources, particularly Human resources. Among IT-intensive firms, the payoffs to the Human and Business resources were significantly greater than among IT-Lagging firms.

The magnitude of the Human resource–Performance relationship seemed rather striking, with Human resource coefficients consistently dwarfing the Business and IT coefficients, whether obtained from home office or remote store data. The results suggest that, of all resources in the IT equation, Human resources are probably the most neglected and difficult to master. They also support the resource-based notion that competitive advantages do not arise not from replicable resources, no matter how pervasive or impressive or economically valuable they may be, but from complex, causally ambiguous, intangible resources.

Our results do not support the optimistic tone that dominated much of the early IT literature, but neither do they give cause for despair. They affirm Keen's (1993) 'fusion' perspective, which finds IT success based on a fusion of People, Business, and Technology resources, with the 'management difference' producing the critical, distinctive advantage. They also support the premises underlying the sociotechnical systems literature (Miller and Rice, 1967), as well as Pfeffer's (1995) notions of gaining competitive advantage through people. Moreover, they support an accumulating body of resource-based empirical studies, including those by Hansen and Wernerfelt (1989)—in which organizational climate and human resource practices explained more performance variance than industry or market share factors—and Powell (1992a, 1992b), in which organizational factors proved as important as the effects of industry and strategic positioning. They also support the Powell (1994, 1995) TQM findings, in which TQM success resulted from intangibles such as employee empowerment and CEO commitment; the Kettinger *et al*. (1994) review that found few sustainable IT financial impacts; and the Zahra and Covin study, which connected strategy with technological policies, concluding that (1993: 474) 'An emphasis on technology alone cannot singularly ensure high performance.'

According to Porter, 'Not all technological change is strategically beneficial; it may worsen a firm's competitive position and industry attractiveness. High technology does not guarantee profitability' (1985: 165). Though we found little evidence of direct effects, either positive or negative, the frequent negative (though nonsignificant) IT–performance correlations suggest that ITs probably did weaken some firms' competitive positions. To Porter's list of IT costs—which included learning costs, vulnerability to technology shifts, and the risk of low-cost competitive imitation—we would add the costs of integrating ITs with existing Human and Business resources, and note that high-performers appeared to focus on strengthening the organization's cultural, structural, and systems infrastructures, and not on adding technologies *per se*. Our data suggest that ITs do not merge themselves automatically with Human and Business resources, and that the more valuable the complementarity, the more difficult it is to achieve. We concluded, based on both statistical and anecdotal data, that the process requires managerial support and forethought, IT–strategy integration, a flair for organizational design, and perhaps a bit of luck. We agree with Kettinger *et al*. that 'the information resources of a firm must be driven by business strategy and integrated into the product and process dimensions of the enterprise based on an understanding of core competencies' (1994: 50).

In calling for a more 'human-centered information management,' Davenport made several observations that help to explain why human resources have such powerful performance impacts on IT systems. The core problem, the author asserts, is that most executives approach the IT decision by examining how people use machines instead of how they use information. The machines need people to make them productive because, according to the author (1994: 122): 'Most of the information in organizations—and most of the information people really care about—isn't on computers. Managers prefer to get information from people; people add value to raw information by interpreting and adding context.' Moreover, the author suggests that, although most IT users either don't know or don't trust those who designed the systems they work on, people only want to use ITs to the extent that they participated in defining them, or trust those who did. Consistent with our own findings, Davenport recommends that (1994: 122): 'To make the most of electronic communications, employees must first learn to communicate face-to-face.'

CONCLUSIONS

The researchers believe this project contributes theory-based conceptual synthesis and empirical evidence to an IT literature still dominated by anecdotes and consultants' IT implementation models. The findings help to explain why some firms struggle while others flourish with the same ITs, and why IT-based advantages tend to dissipate so rapidly; and they suggest a solution based on an integration of IT with the firm's infrastructure of human and business complementary resources. We conclude, in sum, that ITs carry enormous productivity power but, like other powerful weapons, misfire in the wrong hands. In the end, we find ourselves supporting the seemingly universal intuition that tells managers 'Technology alone is not enough.'

In designing the empirical research, the researchers instituted a variety of validating procedures and controls, including extensive pretesting, controlling for industry factors, testing for interrater reliability using remote store managers, on-site interviews and direct observations of ITs in context, confirmation of respondent identities, sample validation through comparisons with population parameters, reliability testing of measurement scales, a sector subsample test, and testing the convergent validity between subjective and objective performance measures.

Still, we acknowledge that our methodology required trade-offs that may limit the use and interpretation of the data. First, because our methodology was cross-sectional, we can only prove association, not causality. Although we believe the causality from Human complementary resources to performance is more plausible than the alternatives, it was not strictly demonstrable using cross-sectional data. Moreover, the cross-sectionality implies that we cannot demonstrate the long-term sustainability of advantages. We attempted to mitigate the significance of this problem by studying an industry where ITs had disseminated sufficiently to confer stable advantages, and by taking multiple-year performance measures. Nonetheless, our data do not prove sustainability, but only that advantages now exist, and that these advantages are associated with some resources but not others.

The study's focus in the retail industry enabled the researchers to control for extraneous industry factors, but may also limit the applicability of the results to other contexts. The researchers chose this industry in part because it had sustained clear and profound IT change in the preceding 20 years, but we acknowledge that some of the specific ITs involved—e.g., POS scanning—have greater visibility in retail than in other industries, and that some technologies vital to other industries may have less importance in retail. The researchers would not expect to find significant industry-based differences for the overall result concerning IT integration with Human and Business resources, but the results for specific technologies may not apply to other industry settings.

It should also be noted that, although this study relies primarily on resource-based theory, other perspectives might also have produced useful insights. For IT research, the transaction cost approach—which takes the transaction as its unit of analysis to explain why firms manage some transactions internally and others in markets (Williamson, 1975; Robins, 1987)—deserves attention. This approach has been used to investigate a variety of organizational activities—including bureaucracy, vertical integration and horizontal diversification (Armour and Teece, 1978; Klein, Crawford and Alchian, 1978; Teece, 1980, 1990)—as well as the organizational impacts of IT (Malone, Yates and Benjamin, 1987; Clemons and Row, 1991). This approach has considerable merit in investigating IT's impacts on organizational governance, particularly in retail, where some analysts claim that ITs have contributed to ongoing industry consolidation by creating scale economies and switching costs, and that transaction cost reductions along the value chain have revolutionized retail–supplier relationships. The EDI-enabled Wal-Mart/Proctor & Gamble relationship suggests the direction these effects are taking, and one industry executive we interviewed predicted that large retailers will soon resemble flea markets, where manufacturers come to display, replace, promote, and sell their goods. This trend could fruitfully be examined from a transaction cost perspective.

We designed this study to fill a rather significant gap in the strategy/IT literature, namely the need for a theoretically grounded empirical study to reconcile the complex array of existing models, cases, and opinions. However, within the vast and diffuse IT literature, we regard this as an early attempt at such reconciliation, and strongly encourage other strategy and IT researchers to attempt competing syntheses. The literature would benefit particularly from studies in other industry contexts, and using alternative theoretical perspectives and methodologies. Several perspectives hold particular promise for contributing to existing IT research, notably transaction cost economics (Williamson, 1975), diffusion of innovation theory (Rogers, 1983), population ecology (Hannan and Freeman, 1984; Carroll, 1993), and agency theory (Jensen and Meckling, 1976; Eisenhardt, 1989). Our results generally support resource-based premises, but competition among a broader range of theoretical perspectives would, in the long run, produce a more complete and useful synthesis.

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APPENDIX 1: HOME OFFICE SURVEY MEASUREMENT SCALES

1A. Human resources

Respondents were asked to indicate the extent to which they agreed or disagreed with the following statements, using a 1–5 scale (5 = strongly agree; 1 = strongly disagree):

Open organization (Open org)

1. In the home office, our people are open and trusting with one another
2. We have very little formal bureaucracy in our company
3. Our people would say this is a loose, informal place to work

Open communications (Open comms)

1. Written and oral communications are very open in our home office
2. Our people communicate widely, not just with their own departments
3. Communications are very open between our home office and our stores

Consensus (Consensus)

1. There is lots of conflict in our home office (reversed)
2. We have lots of conflict between our home office and our stores (reversed)

CEO commitment to IT (CEO commit)

1. Our top executives have clearly indicated their commitment to information technology
2. Our top executives have championed information technology within the company

Flexibility (Flex)

1. In general, our people accept change readily
2. Our people have openly embraced new information technologies
3. We have had very few problems fitting information technologies within our company culture

IT/Strategy information (IT/Strat)

1. Our information technology planning is integrated with the overall business plan

1B. Business resources

Respondents were asked to indicate the extent to which they agreed or disagreed with the following statements, using a 1–5 scale (5 = strongly agree; 1 = strongly disagree):

Supplier relationships (Supplier rels)

1. We have very open, trusting relationships with our suppliers

Supplier-driven IT (Supplier driv)

1. Our suppliers strongly urged us to adopt new information technologies

IT training (Train)

1. Our home office people are well trained in the use of new information technologies
2. Our store personnel are well trained in the use of new information technologies
3. Information technology training is a high priority in our company

Process redesign (Process)

1. We have an overall business plan to redesign our inventory management process
2. We have an overall business plan to redesign our marketing and sales processes
3. Improving company processes has become a key part of our business plan

Teams (Teams)

1. We frequently use cross-departmental teams to solve key problems

Benchmarking (Benchmark)

1. We actively research the best information technology practices of other retailers

IT planning (Planning)

1. We have a formal, long-term strategic plan for information technology
2. We have clearly identified our information technology project priorities
3. We regularly measure the bottom-line effectiveness of our IT projects

1C. Technology resources (In-store)

Respondents were asked to indicate the extent to which they had implemented, in their retail stores, the information technologies indicated below, using a 0–5 scale (5 = highly advanced in implementation; 1 = not yet begun; 0 = do not intend to implement):

Scanning devices (Scanning)

1. Scanners at the point of sale (POS)
2. Scanners logging the receipt of goods at the store
3. Scanners for taking store inventory
4. Handheld, portable scanning terminals

Inventory management technologies (Inv mgt)

1. POS system tracking month-to-date units sold for all items
2. POS system tracking units currently in inventory for any item
3. POS terminals linked to company's central computer
4. Electronic manifesting with distribution center
5. Computer-based automatic reordering at predetermined inventory levels
6. Computerized access to other stores' inventory levels

Automated administration (Admin)

1. Computer-generated sales forecasts
2. Computer-generated bookkeeping and reporting

Automated human resource administration (HR admin)

1. Electronic labor planning and scheduling

2. Electronic time clocks
3. Electronic payroll system
4. Computer software and systems for training employees

Energy management technology (Energy)

1. Automated energy management system (e.g., lights, climate)

Store communications (Store comms)

1. Electronic mail between stores
2. Fax machine

Marketing technology (Marketing)

1. In-store computer marketing (e.g., automated direct mail)

1D. Technology resources (Beyond-store)

Respondents were asked to indicate the extent to which they had implemented the beyond-store information technologies indicated below, using a 0–5 scale (5 = highly advanced in implementation; 1 = not yet begun; 0 = do not intend to implement)

Home office/store communications (HO/Store comms)

1. Satellite communications between stores and home office
2. Electronic mail between stores and home office

Distribution center inventory management (DC inv mgt)

1. Automated inventory management in the distribution center
2. Scanners for price labeling in the distribution center

Distribution center communications (DC comms)

1. Automated reordering between stores and distribution center
2. Electronic manifest between stores and distribution center

Electronic data interchange (EDI)

1. Scanning at distribution center (or stores) to invoice suppliers automatically
2. Electronic data interchange (EDI) with suppliers
3. EDI with suppliers to continuously replenish distribution center
4. EDI with suppliers to continuously replenish stores
5. EDI with suppliers for advance shipping notice
6. Electronic or paperless funds transfer with suppliers

Home-office marketing (HO mktg)

1. Computer-aided marketing (e.g., targeting preferred customers)
2. Computerized data base of customers

1E. Performance

Respondents were asked to indicate the extent to which they agreed or disagreed with the following statements, using a 1–5 scale (5 = strongly agree; 1 = strongly disagree):

Information technology performance (IT perf)

1. New information technologies have dramatically increased our productivity
2. New information technologies have improved our competitive position
3. New information technologies have dramatically increased our sales
4. New information technologies have dramatically increased our profitability
5. New information technologies have improved our overall performance

Overall company performance (Overall perf)

1. Over the past 3 years, our financial performance has been outstanding
2. Over the past 3 years, our financial performance has exceeded our competitors’
3. Over the past 3 years, our sales growth has been outstanding
4. Over the past 3 years, we have been more profitable than our competitors
5. Over the past 3 years, our sales growth has exceeded our competitors’

APPENDIX 2: STORE SURVEY MEASUREMENT SCALES

2A. Human resources

The survey items for in-store information technologies were the same as the home office items (see Appendix 1A above). For the Intangibles items, the store managers were asked to indicate the extent to which they agreed or disagreed with the following statements, using a 1–5 scale (5 = strongly agree; 1 = strongly disagree):

Open organization (S/Open Org)

1. Our people are open and trusting with one another
2. We have very little formal bureaucracy in our company[1]
3. Our people would say this is a loose, informal place to work[1]

Open communications (S/open comms)

1. Written and oral communications are very open in our company
2. Communications are very open between our home office and our stores[1]

Consensus (S/Consensus)

1. There is lots of conflict in our company (reversed)
2. We have lots of conflict between our home office and our stores[1] (reversed)

CEO commitment to IT (S/CEO commit)

1. Our top executives have clearly communicated their commitment to information technology[1]
2. Our top executives have championed information technology within the company[1]

Flexibility (S/Flex)

1. In general, our people accept change readily[1]
2. Our people have openly embraced new information technologies[1]
3. We have had very few problems fitting information technologies within our company culture[1]

2B. Technology resources (In-store)

Same as in Home Office Survey (see Appendix 1C).

[1] Identical to corresponding item in the home office survey.

APPENDIX 3: CORRELATION MATRIX: HOME OFFICE DATA

($N = 65$)	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X25	X26	X27	Y1	Y2
X1 Open org	1																											
X2 Open comms	0.64	1																										
X3 Consensus	0.61	0.61	1																									
X4 CEO commit	0.40	0.40	0.46	1																								
X5 Flex	0.42	0.44	0.40	0.60	1																							
X6 IT/Strat	0.15	0.32	0.31	0.52	0.15	1																						
X7 Supplier rels	0.45	0.53	0.40	0.49	0.55	0.18	1																					
X8 Supplier driv	−0.03	0.08	0.10	0.14	0.06	0.07	0.23	1																				
X9 Train	0.35	0.46	0.44	0.54	0.54	0.51	0.52	0.30	1																			
X10 Process	−0.11	0.01	−0.08	0.19	0.05	0.44	0.05	0.19	0.17	1																		
X11 Teams	0.21	0.43	0.32	0.30	0.14	0.48	−0.02	−0.06	0.27	0.31	1																	
X12 Benchmark	0.18	0.23	0.16	0.34	0.31	0.42	0.21	0.10	0.49	0.27	0.48	1																
X13 IT Planning	0.09	0.18	0.14	0.45	0.26	0.65	0.18	0.06	0.45	0.38	0.35	0.49	1															
X14 Scanning	−0.07	0.01	−0.06	0.07	0.21	0.08	0.10	−0.04	0.28	−0.10	−0.03	0.29	0.18	1														
X15 Inv mgt	−0.26	−0.02	−0.13	−0.01	0.11	0.05	0.04	−0.03	0.13	−0.22	−0.12	0.21	0.10	0.41	1													
X16 Admin	−0.11	0.05	−0.10	0.14	0.19	0.17	0.21	0.05	0.21	−0.04	0.08	0.43	0.23	0.27	0.58	1												
X17 HR Admin	0.11	0.11	0.09	0.27	0.20	0.32	0.13	−0.07	0.33	0.04	0.23	0.46	0.37	0.51	0.39	0.40	1											
X18 Energy	0.00	0.02	−0.08	0.18	0.14	0.28	−0.05	−0.08	0.21	0.05	0.10	0.18	0.25	0.36	0.11	0.28	0.45	1										
X19 Store comms	−0.15	−0.12	0.03	0.24	0.19	0.30	0.11	0.24	0.21	0.07	−0.04	0.10	0.19	0.23	0.44	0.24	0.13	0.21	1									
X20 Marketing	−0.04	−0.01	−0.02	0.09	0.00	0.18	−0.11	−0.13	0.10	0.00	0.19	0.06	0.12	0.11	0.23	0.12	0.14	0.21	0.37	1								
X21 HO/Store com	−0.11	−0.04	−0.01	0.25	0.01	0.24	0.04	0.10	0.11	0.17	0.19	0.19	0.31	0.25	0.33	0.27	0.48	0.25	0.36	0.21	1							
X22 DC inv mgt	0.02	0.08	0.00	0.00	−0.02	0.17	0.05	−0.09	0.23	−0.03	0.08	0.30	0.24	0.41	0.37	0.35	0.33	0.22	0.07	−0.03	0.37	1						
X23 DC comms	−0.24	−0.16	−0.16	−0.18	−0.07	−0.02	−0.12	0.06	0.01	−0.25	−0.05	0.16	0.05	0.24	0.67	0.51	0.27	0.07	0.21	0.01	0.33	0.48	1					
X24 EDI	−0.17	0.03	−0.13	0.14	0.09	0.18	0.07	0.19	0.15	0.21	0.10	0.30	0.36	0.47	0.24	0.43	0.37	0.29	0.28	0.08	0.38	0.46	0.33	1				
X25 HO mktg	−0.10	−0.01	0.10	0.19	0.04	0.14	0.02	−0.03	0.07	0.00	0.09	−0.05	−0.01	−0.05	0.29	0.18	0.11	0.10	0.34	0.66	0.24	−0.01	0.07	0.10	1			
X26 In emps	−0.20	−0.10	−0.09	0.06	−0.09	0.21	−0.23	0.30	0.03	0.12	0.30	0.34	0.31	0.25	−0.04	0.27	0.48	0.46	0.02	−0.02	0.39	0.26	0.29	0.51	−0.15	1		
X27 Firm age	−0.14	−0.19	0.12	−0.16	−0.13	0.02	−0.16	0.10	−0.14	0.12	0.12	0.00	−0.01	0.00	−0.08	−0.14	−0.04	−0.08	0.14	0.01	0.06	−0.03	0.03	0.14	0.04	0.26	1	
Y1 IT Perf	0.40	0.46	0.32	0.33	0.37	0.22	0.26	0.08	0.50	0.00	0.39	0.46	0.21	0.21	0.29	0.42	0.28	0.20	0.08	0.17	0.21	0.34	0.16	0.17	0.02	0.08	−0.23	1
Y2 Overall Perf	0.33	0.44	0.31	0.28	0.25	0.29	0.20	0.11	0.26	0.01	0.22	0.05	0.18	−0.04	−0.10	0.10	0.07	0.01	−0.14	−0.05	−0.17	−0.07	0.03	−0.03	0.01	0.02	−0.11	0.161

APPENDIX 4: CORRELATION MATRIX: STORE DATA

($N = 43$)	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1 Open org	1											
X2 Open comms	0.74	1										
X3 Consensus	0.36	0.68	1									
X4 CEO commit	0.17	0.35	0.15	1								
X5 Flex	0.46	0.68	0.37	0.42	1							
X6 Scanning	0.01	–0.06	–0.29	0.27	0.09	1						
X7 Inv mgt	0.19	0.25	–0.07	0.39	0.42	0.38	1					
X8 Admin	–0.02	0.09	0.08	0.31	0.17	0.31	0.68	1				
X9 HR Admin	–0.07	0.07	–0.09	0.33	0.35	0.42	0.56	0.48	1			
X10 Energy	–0.02	0.06	–0.02	0.33	0.09	0.47	0.52	0.53	0.30	1		
X11 Store comms	–0.14	–0.14	–0.06	–0.18	–0.02	–0.07	0.22	0.16	0.20	0.15	1	
X12 Marketing	–0.01	0.14	0.09	0.23	0.34	0.16	0.52	0.40	0.49	0.30	0.42	1