Pergamon

Technovation 21 (2001) 147–156

technovation

www.elsevier.com/locate/technovation

Information systems and competitive advantage: a competency-based view

Michael J. Zhang [a,*], Augustine A. Lado [b]

[a] *Department of Management, The Chinese University of Hong Kong, Shatin, N.T. Hong Kong, People's Republic of China*
[b] *Department of Management and Labor Relations, James J. Nance College of Business Administration, Cleveland State University, Cleveland, OH 44115, USA*

Received 24 November 1999; received in revised form 20 March 2000; accepted 27 March 2000

Abstract

In this paper, we offer a competency-based view of how information systems (IS) can be used to achieve competitive advantage. Building on the resource-based research that links distinctive organizational competencies to sustainable competitive advantage, we argue that the potential contributions of IS to competitive advantage can be understood in terms of their impact on the development and utilization of distinctive organizational competencies. To explore the potential IS linkage to organizational competencies, we examine whether and to what extent IS can be used to foster and facilitate the development and utilization of three types of organizational competencies at the operational level: input-based competencies, transformation-based competencies and output-based competencies. Our analysis shows that IS may play an important role in enabling firms to develop and leverage these organizational competencies. We discuss research and managerial implications of the competency-based framework for the strategic management of IS.

Keywords: Information systems; Organizational competencies; Competitive advantage

1. Introduction

For scholars and practitioners concerned with the strategic management of computer-based information systems (IS), one central issue is whether IS contribute to competitive advantage. A large body of the strategic IS literature has attempted to address this issue by empirically testing the relationship between levels of IS investment and firm performance with industry- and firm-level data (Alpar and Kim, 1990; Bharadwaj et al., 1999; Brynjolfsson and Hitt, 1996; Cron and Sobol, 1983; Floyd and Woolridge, 1990; Harris and Katz, 1991; Hitt and Brynjolfsson, 1996; Li and Ye, 1999; Loveman, 1988; Tam, 1998). Several recent reviews of this body of research (Dos Santos and Peffers, 1993; McKeen and Smith, 1993; Wilson, 1993) have shown that the empirical evidence for IS effects on firm performance is generally inconclusive. Some studies have found a positive relationship between IS investment and firm performance (e.g., Alpar and Kim, 1990; Bharadwaj et al., 1999; Brynjolfsson and Hitt, 1996), while others have reported a zero or even a negative relationship (e.g., Barua et al., 1995; Hitt and Brynjolfsson, 1996; Weill, 1988). Although these mixed findings may be attributed to several measurement problems (Brynjolfsson, 1993; McKeen and Smith, 1993), Lucas (1993) suggests that the appropriate use of IS may be the missing link in the relationship between IS investment and firm performance.

During the 80s, a variety of theoretical or conceptual frameworks was advanced to specify how IS could be properly used to gain competitive advantage (cf. Neumann, 1994). The most dominant and influential framework is the "Structure-Conduct-Performance" paradigm of industrial organization economics (Porter 1980, 1981). According to this framework, IS may engender competitive advantage insofar as they are used to manipulate an industry's structural parameters, such as increasing a firm's bargaining power over its buyers and

* Corresponding author. Tel./fax: +852-2609-7740.
E-mail addresses: michaelz@baf.msmail.cuhk.edu.hk (M.J. Zhang), a.lado@csuohio.edu (A.A. Lado).

0166-4972/01/$ - see front matter
PII: S0166-4972(00)00030-4

suppliers, heightening entry barriers, and deterring competitive rivalry (McFarlan, 1984; Parsons, 1983; Porter and Millar, 1985).

Despite its popularity in guiding much of the strategic IS research and practice in the past decade, the I/O framework has limited researchers' efforts to investigate the idiosyncratic resources as the drivers of superior firm performance. Recently, strategy researchers who espouse the "resource-based" view of the firm (Barney, 1991; Conner, 1991; Mahoney and Pandian, 1992; Wernerfelt, 1984) have rejected the I/O assumptions of resource homogeneity and mobility. Instead, they entertain the view that the firm is a collection of hard-to-copy, idiosyncratic resources and capabilities (Conner, 1991; Dierickx and Cool, 1989). Accordingly, to the extent that these resources are valuable, rare, imperfectly imitable, and non-substitutable (Barney, 1991), their development and deployment hold the prospects for sustainable competitive advantage and superior firm performance.

Researchers have recently used the resource-based perspective to reexamine the issue of whether and to what extent IS can generate competitive advantage for a firm relative to its competitors. From this perspective, Clemons and Row (1991) and Feeny and Ives (1990) have shown that IS which exploit asymmetrical differences in firm resources (e.g., customer databases) may lead to sustainable competitive advantage. In their study of IS uses in the retail industry, Powell and Dent-Micallef (1997) have found that firms with IS that are synergistically linked to human and business resources outperformed those with IS that lacked those synergies. Lado and Zhang (1998) developed a conceptual model that shows that expert systems (ES) that foster knowledge development and utilization and engender a reciprocal, mutually enhancing relationship with organizational competencies may yield durable competitive advantage.

While the resource-based analyses of IS have contributed enormously to our understanding of the conditions under which IS resources can confer sustainable competitive advantage (e.g., Mata et al., 1995), there remain two theoretical gaps that motivated this paper. First, researchers who have analysed IS in terms of whether they exhibit the characteristics of a rent-generating resource (i.e. value, rareness, imperfect imitability, and non-substitutability) have generally concluded that IS may at best be the sources of "competitive parity" and "normal" or average economic performance (Mata et al., 1995). An implication of this analysis is that IS may only represent a "strategic necessity", in that using these resources to develop and implement organizational strategies "may not create above-normal economic performance for a firm, but failure to exploit them can put a firm at a competitive disadvantage" (Barney, 1997; Clemons and Kimbrough, 1986). We take a "dynamic capabilities" perspective (Schulze, 1994; Teece et al., 1997), however, and argue that IS may hold a greater potential to gain and sustain competitive advantage through facilitating the development and leveraging of organizational competencies. Therefore, researchers and managers need to more systematically investigate the *indirect* effects of IS in mobilizing knowledge-based, "invisible assets" that arguably form the basis of sustained competitive advantage (Itami, 1987).

Accordingly, we analyse in this paper the various ways in which a firm may use its IS to foster and facilitate the development and deployment of firm-specific resources and capabilities to achieve its strategic goals. To facilitate our analysis, we focus on three types of organizational competencies (input-based competencies, transformation-based competencies and output-based competencies) as potential sources of sustainable competitive advantage (Lado et al., 1992; Lado and Wilson, 1994). The conceptual framework of our analysis is depicted in Fig. 1.

Second, extant research examining IS linkage to competitive advantage within the resource-based view has tended to focus on the "strategic" or higher level of organizational competencies (Brumagim, 1994). Unfortunately, at this level of analysis, researchers have found a tenuous or non-existent link between IS and competitive advantage (Powell and Dent-Micallef, 1997). However, we argue for a need to adopt a *lower* or "functional" level of analysis and re-examine how IS contribute to the creation and sustainability of a firm's competitive advantage. This level of analysis may be more "appropriate" since, like "human resource systems" (Lado and Wilson, 1994), IS may perform a "support" function in the development and implementation of value-enhancing organizational strategies. Interestingly, earlier work in the "distinctive competence" literature assumed this "functional" level in analysing the role of specific organizational units or departments in developing and deploying rent-yielding distinctive competencies (e.g., Hitt and Ireland, 1985; Snow and Hrebiniak, 1980). Thus, we adopt the functional or "operational" level of analysis and investigate the extent to which IS support the development and deployment of "production/maintenance" competencies (Brumagim, 1994). Unlike the early work on distinctive competencies just cited, we focus on examining how IS support the development and deployment of competencies *across* organizational functions. This broader conceptualization enables us to analyse IS role in fostering organizational competencies and engendering the cross-functional inte-

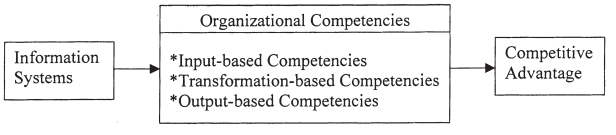

Fig. 1. Information systems, organizational competencies and competitive advantage.

gration necessary to achieve scale, scope, and learning-curve economies for a firm (Porter, 1985).

In the remainder of the paper, we first provide a synthesis of the related literature on organizational competencies. Then, we elaborate on IS role in fostering the development and deployment of three types of organizational competencies at the operational level. Lastly, we present the conclusions and implications of our analysis for the strategic management of IS.

2. Organizational competencies

Within the resource-based literature, the concept of organizational competencies has evolved over the years. Early thinking about organizational competencies focused on the skills and capabilities of a firm (Stalk et al., 1992). Selznick (1957) first coined the term, "distinctive competence", to describe things that an organization does especially well in comparison to its competitors. Following Selznick, Hofer and Schendel (1978) (p. 25) refer to distinctive competence as the "patterns of... resource and skill deployments that will help it [the firm] achieve its goals and objectives".

Recent conceptualization of organizational competencies, however, tends to include resources as part of organizational competencies. For example, Reed and DeFillippi (1990) (pp. 89–90) define competency as the "particular skills and resources a firm possesses, and the superior way in which they are used". In their discussion of the "core competence", Helleloid and Simonin (1994) include a firm's unique human, physical, organizational and coordinating resources. Teece et al. (1997) also consider resources (complementary assets) as part of core competence. Following Lado and Wilson (1994) (p. 702), we define organizational competencies as "firm-specific resources and capabilities that enable the organization to develop, choose, and implement value-enhancing strategies".

A variety of organizational competency typologies has been advanced in the resource-based literature, reflecting a wide range of research interests and theoretical perspectives (e.g., Collis, 1994; Grant, 1991; Henderson and Cockburn, 1994; Lado et al., 1992; Treacy and Wiersema, 1993). Following an open systems approach to analysing organizational resources and capabilities (Brumagim, 1994; Lado et al., 1992), we focus on three types of organizational competencies as potential sources of sustainable competitive advantage: input-based competencies, transformation-based competencies, and output-based competencies[1].

Input-based competencies include the physical resources, organizational capital resources, and human resources that enable a firm's transformational processes to create and deliver products and services that are valued by customers (Lado et al., 1992). To the extent that these competencies represent specialized assets (Teece, 1987; Williamson, 1985) and tacit knowledge and skills (Polanyi, 1967; Reed and DeFillippi, 1990), their economic benefits can be long lasting. Transformation-based competencies are "organizational capabilities required to advantageously convert inputs into outputs" (Lado et al., 1992). Transformation-based competencies that allow firms to possess a unique product market position (Barney, 1992; Lado and Wilson, 1994; Peteraf, 1993) and are embedded in organizational routines built overtime (Collis, 1994; Grant, 1991) can be sources of sustainable competitive advantage. Output-based competencies encompass all knowledge-based and invisible strategic assets ranging from corporate reputation or image to product or service quality, and customer loyalty (Lado and Wilson, 1994). Since output-based competencies entail intangible and firm-specific resources accumulated over a considerable period of time and are not freely tradeable, they can generate durable economic returns (Barney, 1991; Dierickx and Cool, 1989; Weigelt and Camerer, 1988).

3. IS support of organizational competencies

3.1. IS support of input-based competencies

According to Lado et al. (1992), input-based competencies may be derived from human and non-human resources, both tangible and intangible. Among the intangible input resources that hold the potential of generating economic returns are the unique, firm-specific information and knowledge (Feeny and Ives, 1990; Hall, 1992; Itami, 1987; King and Grover, 1991; Lado and Wilson, 1994; Mahoney and Pandian, 1992; Winter, 1987). With their information storage, processing and communication capabilities, IS may be used to facilitate the collection, accumulation and development of critical information and knowledge. We analyse IS role with respect to: (1) facilitating internal information gathering and communication, (2) facilitating external information gathering and communication, (3) transforming data into information and knowledge, and (4) developing and upgrading firm-specific knowledge and expertise.

[1] Lado et al. (1992) include "managerial competencies" (referring to "the unique capabilities of an organization's strategic leaders to articulate a strategic vision, communicate the vision throughout the organization, and empower organizational members to realize that vision" [Lado and Wilson, 1994: p. 703]) in their "competency-based" model of competitive advantage. However, since our focus is at the "functional" or operational level of the firm, we have not explicitly addressed this type of construct in the present analysis.

3.1.1. Facilitating internal information gathering and communication

Hammer and Mangurian (1987) note that electronic communication systems (ECS) or telecommunication systems can rapidly transmit information between geographical dispersed sites. This time compression capability significantly reduces or even eliminates the "information float" (time elapsed between the production of information and its communication to the user). In addition, ECS support asynchronous communication so that not all parties have to participate in the communication process at the same time (Rice and Bair, 1984). With the emergence of the Internet, communication can be further enhanced by linking existing ECS to the Internet which provides wider geographical breadth of access and more media delivery methods (audio and video) at relatively lower costs (Stroud, 1998). By utilizing ECS and the Internet, firms may become more effective and efficient in overcoming time, geographical and organizational barriers in collecting information of strategic importance (Alter, 1996; Keen, 1988).

The storage and retrieval capacities of IS may also contribute to the collection of critical internal information. With ongoing increases in storage volumes and such features as automatic capturing, on-line access, and user-friendly interface, transaction processing systems (TPS) enable firms to capture and retain more data with more completeness and precision (Huber, 1991; Sinkula, 1994). More recently, some companies have incorporated the hypertext and hypermedia technologies into their IS to store data in rich context (Stein and Zwass, 1995). Some companies have used intranets to retain not only information, but also sources of information (e.g., listing of employees who hold certain critical information) to facilitate search, access and retrieval of information (Goodman and Darr, 1998; Senna, 1997; Zorn et al., 1997).

3.1.2. Facilitating external information gathering and communication

IS may serve as an effective and efficient tool for gathering and processing information of strategic importance from external sources (e.g., customers, suppliers and dealers). With online access to various external databases, executive information systems (EIS) enable managers to search and retrieve more external information about its suppliers, customers, competitors, financial organizations, stockholders, regulatory bodies, and interest groups, etc. in a timely manner (Rasheed and Datta, 1991; Synnott, 1987; Turban, 1990). Interorganizational systems (IOS) using electronic data interchange (EDI) and other means to provide electronic links between firms are also capable of facilitating quick and accurate information exchange between a firm and its trading partners (Cash and Konsynski, 1985; Johnson and Vitale, 1988; King and Grover, 1991; Treacy and Wiersema, 1993; Venkatraman, 1994). Researchers have empirically shown that EDI-based systems help speed up communication between buyers and suppliers (Banerjee and Golhar, 1994; Reekers and Smithson, 1994; Scala and McGrath, 1993) and that the improved information exchange results in significant operational efficiencies (Kekre and Mukhopadhyay, 1992; Mukhopadhyay et al., 1995; Srinivasan et al., 1994).

3.1.3. Transforming data into information and knowledge

IS researchers have long argued that data collected in their original forms are often not useful and thus do not represent information (data whose form and content are appropriate for a particular use) (Davis, 1974; King and Grover, 1991; Turban, 1990). In order for data to become information, their forms and/or contents often need to be transformed in such ways that are suitable for a specific task (i.e. converted into information). The advanced information processing capabilities (formatting, filtering and summarizing) in management information systems (MIS), decision support systems (DSS) and EIS can be used to facilitate the transformation process and enhance the value of information by increasing its form, time, and place utilities (Ahituv and Neumann, 1982; Andrus, 1971; King and Grover, 1991). In addition to the traditional function of transforming data, IS have recently been used to extract information and knowledge from existing databases. This is evident in the growing use of expert systems (ES), neural networks and case-based reasoning systems to generate new facts and uncover important relationships that can provide competitive advantage (Berry et al., 1994; Grupe and Owrang, 1995).

3.1.4. Developing and upgrading firm-specific knowledge and expertise

The potential IS support of input-based competencies is not limited to the acquisition and development of critical information. Rather, IS can play an important role in helping a firm develop and mobilize its distinctive knowledge and expertise to gain competitive advantage (Lado and Zhang, 1998). Through their capabilities to represent and manipulate human knowledge, ES (also known as knowledge-based systems) have become an increasingly popular tool for the firm to preserve, assemble and transfer effectively and efficiently the scarce but valuable skills and expertise of its employees (Beerel, 1993; Turban, 1990). The literature on the strategic applications of ES is replete with anecdotal evidence on firms which have successfully applied ES to reap economic benefits such as lower costs and higher product/service values to customers (Ashmore, 1989; Holsapple and Whinston, 1987; Leonard-Barton and Sviokla, 1988; Yamasaki and Manoochehri, 1990).

Other types of IS may also be used to store, distribute,

and upgrade organizational knowledge (Goodman and Darr, 1996; Stein and Zwass, 1995). Case-based reasoning systems have been used to represent and store knowledge in an organized library of cases (Allen, 1994; Kolodner and Mark, 1992). More recently, some firms have used intranets to store critical documents and organizational discussions. To facilitate search, access and retrieval of soft knowledge, some intranets maintain listings of employees and managers along with their areas of specialization and use software search engines to identify knowledge or holders of desired knowledge (Senna, 1997; Zorn et al., 1997). Andersen Consulting, for example, has used Lotus Notes to facilitate organization-wide storage, exchange and modification of the best practices—solutions that can be applied to a wide range of organizational problems (Goodman and Darr, 1996).

3.2. Is support of transformation-based competencies

A variety of transformation-based competencies (e.g., operational excellence, lean manufacturing, and stockless inventory) have been discussed in the strategic management literature (MacDuffie and Krafcik, 1990; Stalk et al., 1992; Treacy and Wiersema, 1993). These competencies enable a firm to gain competitive advantage through (a) improving operational efficiency, (b) enhancing operational flexibility, or (c) fostering cross-functional integration. Operational efficiency reflects the ability to transform inputs into outputs at lower costs and/or with higher values to customers than competitors (Collis, 1994). Operational flexibility is concerned with the ease with which transformation processes can be adjusted to meet changes in customer needs and business conditions (Stalk et al., 1992; Upton, 1995). Cross-functional integration describes the capability to coordinate and integrate two or more distinct processes for efficiency and/or flexibility (Grant, 1991; Porter, 1985; Prahalad and Hamel, 1990; Stalk et al., 1992).

3.2.1. Improving operational efficiency

Researchers have amply documented how IS can be used to achieve greater operational efficiencies. For example, Porter and Millar (1985) note that IS may be used to reduce the costs of information processing and physical processing of value-chain activities. Alter (1996) suggests that IS can reduce operational costs when they are used to eliminate waste (e.g., unproductive uses of time, unnecessary paperwork, unnecessary work steps and delays, and unnecessary variations in procedures and systems) and automate various value-added activities (e.g., customer interfaces, product design, and manufacturing). Using firm-level data, researchers have found a significant positive relationship between IS and productivity improvements (Barua and Lee, 1997; Brynjolfsson and Hitt, 1996; Kelley, 1994; Reardon et al., 1996). Weill's study (Weill, 1992) of IS investment in the valve-manufacturing industry provides further evidence that when, IS are designed to support a firm's daily transactions, they can engender higher levels of labor productivity.

3.2.2. Enhancing operational flexibility

Bakos and Treacy (1986) consider information technology as an inherent flexibility technology that can improve product adaptability and produce scale economies from smaller production runs. Alter (1996) identifies two ways IS may increase the flexibility in business processes. First, IS can be used to systematize the form and content of product specifications, making it easier to handle variations. Second, IS can make it possible to control production processes based on computer-generated product specifications.

Research on the organizational impact of computer-aided manufacturing (CAM) and flexible manufacturing systems (FMS) shows that IS can be built into the production processes to shorten product design cycles and facilitate product-line changeover, thereby increasing a firm's manufacturing flexibility in terms of faster speed and greater product variety (Alter, 1996; Boynton, 1993; Goodman and Lawless, 1994; Goldhar and Lei, 1995; Parker and Case, 1993). Allen-Bradley's highly automated factory is an example of achieving flexibility through IS (Chase and Garvin, 1989). The factory can manufacture 1,025 different electronic contractors and relays with zero defects in lot sizes as small as one. The time from order placement to completion is one day. Such high levels of flexibility are made possible by using IS to transmit orders to the factory and control the machines within the factory.

3.2.3. Fostering cross-functional integration

Alter (1996) identified three levels of cross-functional integration IS may support: information sharing, coordination, and collaboration. At the level of information sharing, different business processes share some of the same information even though they involve little mutual responsiveness. At the level of coordination, different business processes pass information back and forth to coordinate their efforts toward a common objective, while maintaining their unique identities and functions. At the level of collaboration, different business processes merge part or all of their identities to accomplish the larger objective of the firm.

Because they enable more timely, accurate and complete information flows, ECS can be used to facilitate information sharing and coordination between different value activities (Alter, 1996; Neumann, 1994; Porter and Millar, 1985). Furthermore, IS that support and link computer-aided design (CAD), computer-aided engineering (CAE) and CAM enable different functions to directly utilize the electronic information flows between them with little manual support or coordination

(Boynton, 1993; Joshi, 1998). Computer-integrated manufacturing (CIM) can foster greater collaboration among marketing, engineering, manufacturing, and other business functions within firms. This technology combines telecommunication systems, CAD and robots with other modern manufacturing technologies such as advanced sensor and control systems (Alter, 1996; Gold, 1989; Goldhar and Lei, 1995). Studies of manufacturing and service firms have documented the operational benefits (e.g., improved productivity, reduced lead times and increased flexibility) accruing from IS-enabled cross-functional integration (Fitzgerald, 1990; Gold, 1989; Groves, 1990; Koelsch, 1990; McFadden and Hoffer, 1991).

IS can also be used to foster cross-functional integration between firms via EDI or the Internet (Joshi, 1998). Researchers have shown that the use of EDI facilitates information sharing and coordination between a firm and its customers or suppliers and improves efficiency in transmitting important documents, such as purchase orders and invoices (Banerjee and Golhar, 1994; Cash and Konsynski, 1985; Reekers and Smithson, 1994; Scala and McGrath, 1993; Venkatraman and Zaheer, 1990). For example, Walmart Stores has developed an EDI-based system to coordinate procurement and inventory control activities among its distribution centers, retail stores and suppliers. This system is now considered as a key component of Walmart's unique logistics (stockless inventory) capability that enables the company to significantly reduce paperwork, inventory costs and stock-out costs (Goodman and Lawless, 1994; Stalk et al., 1992). The main advantage of IS-based integration between firms is that it allows firms to use the vertical applications of IS (virtual integration) to achieve the benefits of vertical integration, while also realizing the production economies available to separate, specialized firms (Clemons and Row, 1991; Konsynski and McFarlan, 1990). Although competitors that are vertically integrated may potentially match the level of operational integration, it is not as easy for them to match the production economies and flexibility of independent and specialized firms that are connected together with such information technologies (Clemons and Row, 1991).

3.3. Is support of output-based competencies

A firm may develop superior product/service reputation and high customer loyalty by using IS to improve its relationships with customers and suppliers. By linking and integrating a firm's internal routines with those of its customers and suppliers through EDI, IOS may promote close relationships between the firm and its customers and suppliers (Cash and Konsynski, 1985; Konsynski and McFarlan, 1990; Reekers and Smithson, 1994; Runge and Earl, 1988; Venkatraman, 1994). Such close relationships in turn facilitate the timely and efficient flows of market information (from the customers or suppliers to the firm) and corporate information (from the firm to the customers or suppliers) which are deemed critical to the accumulation of invisible assets (Itami, 1987). Friends Provident (an insurance company), for example, has used IS to increase customer loyalty. This company has developed a videotext-based system (FRENTEL) for providing on-line quotation service which allows brokers to obtain quotations and surrender values directly from the insurer's central computer (Runge and Earl, 1988).

IS contributions to product/service reputation and customer loyalty may come from their support of customer intimacy and customer service (Treacy and Wiersema, 1993). Researchers have documented how firms establish intimacy with customers through "data-base marketing" or "data-mining". Such an approach enables firms to determine customers' needs, based on manipulations of customer profiles and past buying behaviors, and to specify complex and dynamic customers' preferences and tastes for particular services (Berry et al., 1994; Carmody, 1994; Francese, 1990; Grupe and Owrang, 1995; Hays, 1994). Francese's (1990) case study of data-base mining in the hotel industry shows how some hotels have cultivated brand loyalty by building and analysing customer databases containing demographic, socioeconomic, personal and financial information to identify the best customers and their attributes.

Building product/service reputation may require empowerment of employees to solve customer problems as they arise (Lado et al., 1992). A firm can use its IS to empower its employees by providing them with the information, tools and training they needed to solve customers problems (Alter, 1996). For example, Kraft General Foods has not only decentralized its marketing operations to increase the decision making power of its sales force, but it has also given its salespeople the support of a centralized information system (Treacy and Wiersema, 1993). The system assists sales teams in accessing and analysing sales (e.g., purchase by store, category and product) and consumer (e.g., demographic and buying-habit) data collected from 30,000 food stores nationwide to develop a repertoire of usable promotion programs, products, value-added ideas, and selling tools. In another example, IBM developed an expert system to train novice technicians how to fix computer disk drives. The system not only enabled the trainees to learn the best knowledge about disk drive repair, but also significantly reduced training time from 14–16 months to 3–5 months (Feigenbaum et al., 1988).

4. Conclusions and implications

In this paper, we offer a competency-based view of how IS can be utilized to gain competitive advantage.

Building on the resource-based research that links distinctive organizational competencies to sustainable competitive advantage, we argue that the potential contributions of IS to competitive advantage can be understood in terms of their effects on the development and utilization of distinctive organizational competencies. To explore the potential IS linkage to organizational competencies, we examine whether and to what extent IS can be used to support three types of organizational competencies at the operational level: input-based competencies, transformation-based competencies and output-based competencies. Our analysis shows that IS may play an important role in enabling firms to develop and leverage these organizational competencies.

Linking IS to competitive advantage from a competency-based perspective helps shift the focus of strategic IS applications to the internal operations of a firm. The I/O model that has dominated current thinking and research of strategic IS management places heavy emphasis on the external forces in the firm's environment as potential targets of strategic IS applications. Our competency-based analysis shows that opportunities for applying IS strategically may lie inside the firm, especially at the operational level. Accordingly, firms interested in the competitive applications of IS should deploy or re-deploy their IS in such ways that enable them to develop and leverage their unique operational resources and capabilities.

As mentioned before, our framework differs from the static view in the current resource-based analyses of IS (Mata et al., 1995). The static analysis of IS focuses mainly on system characteristics in evaluating the potential competitive impact of IS and thus offers a narrow view of the conditions under which IS can be a source of sustainable competitive advantage. As illustrated in our analysis, the potential contributions of IS to durable competitive advantage depend as much on what they are as on how they are used. In other words, IS that are not rare, imperfectly and non-substitutable may be more than a "strategic necessity". They can play a supportive, yet important role in helping a firm gain and sustain competitive advantage.

Linking IS to organizational competencies in assessing the strategic impact of IS may also shed some light on how to sustain competitive advantage derived from IS. Lado and Zhang (1998) note that organizational competencies may affect a firm's ability to develop, upgrade and replenish its IS for competitive advantage. To the extent that organizational competencies are firm specific and hard to imitate and substitute, a reciprocal and mutually enhancing relationship between IS and organizational competencies may help prolong the competitive advantage gained from IS support of organizational competencies. Future research should then further investigate the interplay between IS and different organizational competencies and its impact on the sustainability of IS-derived advantage.

Finally, while we focus on IS effects on operational competencies in our analysis, our framework can be extended to other types of organizational competencies such as managerial competencies (Lado et al., 1992), organizational learning (Helleloid and Simonin, 1994) and organizational innovation (Brumagim, 1994). For example, a growing body of research has been recently conducted to analyse how information technology can be harnessed to facilitate organizational learning and knowledge management (e.g., Bolisani and Scarso, 1999; Goodman and Darr, 1998). Research on IS linkages to various organizational competencies would further enhance our understanding of the different ways IS may be used to impact a firm's bottom line.

References

Ahituv, N., Neumann, S., 1982. Principles of Information Systems for Management. William C. Brown, Dubuque, IA.

Allen, B.P., 1994. Case-based reasoning: business applications. Communications of the ACM 37 (3), 40–42.

Alpar, P., Kim, M.A., 1990. A microeconomic approach to the measurement of information technology value. Journal of Management Information Systems 7 (2), 55–69.

Alter, S., 1996. Information Systems: A Management Perspective. Benjamin/Commmings, New York.

Andrus, R.R., 1971. Approaches to information evaluation. MSU Business Topics, Summer, 40–46.

Ashmore, G.M., 1989. Applying expert systems to business strategy. The Journal of Business Strategy 10 (5), 46–49.

Bakos, J.Y., Treacy, M.E., 1986. Information technology and corporate strategy: a research perspective. MIS Quarterly 10 (2), 107–119.

Banerjee, S., Golhar, D.Y., 1994. Electronic data interchange: characteristics of users and nonusers. Information and Management 26, 65–74.

Barney, J.B., 1991. Firm resources and sustained competitive advantage. Journal of Management 17 (1), 99–120.

Barney, J.B., 1992. Integrating organizational behavior and strategy formulation research: a resource-based analysis. In: Shrivastava, P., Huff, A., Dutton, J. (Eds.), Advances in Strategic Management, vol. 8. JAI Press, Greenwich, CT, pp. 39–61.

Barney, J.B., 1997. Gaining and Sustaining Competitive Advantage. Addison–Wesley, Reading, MA.

Barua, A., Kriebel, C.H., Mukhopadhyay, T., 1995. Information technologies and business value: an analytic and empirical investigation. Information Systems Research 6 (1), 3–23.

Barua, A., Lee, B., 1997. The information technology productivity paradox revisited: a theoretical and empirical investigation in the manufacturing sector. The International Journal of Flexible Manufacturing Systems 9, 145–166.

Beerel, A., 1993. Expert systems in business. Ellis Horwood, New York.

Berry, J., Verity, J., Kerwin, K., DeGeorge, G., 1994. Database marketing. Business Week, September 5, 56-62

Bharadwaj, A.S., Bharadwaj, S.G., Konsynski, B.R., 1999. Information technology effects on firm performance as measured by Tobin's q. Management Science 45 (6), 1008–1024.

Bolisani, E., Scarso, E., 1999. Information technology management: a knowledge-based perspective. Technovation 19, 209–217.

Boynton, A.C., 1993. Achieving dynamic stability through information technology. California Management Review, Winter, 58–77.

Brumagim, A.L., 1994. A hierarchy of corporate resources. In: Shrivastava, P., Huff, A.S., Dutton, J.E. (Eds.), Advances in Strategic Management, vol. 10A. JAI Press, Greenwich, CT, pp. 81–112.

Brynjolfsson, E., 1993. The productivity paradox of information technology. Communications of the ACM 35, 66–77.

Brynjolfsson, E., Hitt, L., 1996. Paradox lost? Firm-level evidence on the returns to information systems spending. Management Science 42 (4), 541–558.

Carmody, D., 1994. Lifeblood at Reader's Digest is a 40-year-old data base. The New York Times, May 17, 1

Cash, J.I., Konsynski, B.R., 1985. IS redraws competitive boundaries. Harvard Business Review 63 (2), 134–142.

Chase, R.B., Garvin, D.A., 1989. The service factory. Harvard Business Review 67 (4), 61–69.

Clemons, E.K., Kimbrough, S.O., 1986. Information systems, telecommunications and their effects on industrial organization. In: Proceedings of the Seventh International Conference on Information Systems, San Diego CA, pp. 99–108.

Clemons, E.K., Row, M.C., 1991. Sustaining IT advantage: the role of structural differences. MIS Quarterly 15 (3), 275–292.

Collis, D., 1994. How valuable are organizational capabilities? Strategic Management Journal 15, 143–152.

Conner, K.R., 1991. A historical comparison of resource-based theory and five schools of thought within industrial organization economics: do we have a new theory of the firm? Journal of Management 17 (1), 121–154.

Cron, W.L., Sobol, M.G., 1983. The relationship between computerization and performance: a strategy for maximizing the economic benefits of computerization. Information and Management 6 (3), 171–181.

Davis, G.B., 1974. Managing Information Systems: Conceptual Foundations, Structure, and Development. McGraw–Hill, New York.

Dierickx, I., Cool, K., 1989. Asset stock accumulation and sustainability of competitive advantage. Management Science 35 (12), 1504–1513.

Dos Santos, B.L., Peffers, K., 1993. Firm level performance effects: a framework for information technology evaluation research. In: Banker, R.D., Kauffman, R.J., Mahmood, M.A. (Eds.), Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage. Idea Group Publishing, Harrisburg, PA, pp. 359–374.

Feeny, D.F., Ives, B., 1990. In search of sustainability: reaping long-term advantage from investments in information technology. Journal of Management Information Systems 7, 27–46.

Feigenbaum, E., McCorduck, P., Nii, H.P., 1988. The Rise of the Expert Company. Times Books, New York.

Fitzgerald, M., 1990. "When" is now at Sears. Computer World 8, 67–71.

Floyd, S., Woolridge, B., 1990. Path analysis of the relationship between competitive strategy, information technology, and financial performance. Journal of Management Information Systems 7 (1), 47–64.

Francese, P.A., 1990. Data-base marketing: building customer profiles. Cornell Hotel and Restaurant Administration Quarterly 31 (1), 60–63.

Gold, B., 1989. Computerization in domestic and international manufacturing. California Management Review 31 (2), 129–143.

Goldhar, J.D., Lei, D., 1995. Variety is free: manufacturing in the twenty-first century. Academy of Management Executive 9 (4), 73–86.

Goodman, P.S., Darr, E.D., 1996. Exchanging best practices through computer-aided systems. Academy of Management Executive 10 (2), 7–19.

Goodman, P.S., Darr, E.D., 1998. Computer-aided systems and communities: mechanisms for organizational learning in distributed environments. MIS Quarterly 23 (4), 417–440.

Goodman, R.A., Lawless, M.W., 1994. Technology and Strategy. Oxford University Press, New York.

Grant, R.M., 1991. The resource-based theory of competitive advantage: implications for strategy formulation. California Management Review 33 (3), 114–135.

Groves, C., 1990. Hands-off manufacturing transcends the limits of CIM. Industrial Engineering 22 (8), 29–31.

Grupe, F.H., Owrang, M.M., 1995. Data base mining: discovering new knowledge and competitive advantage. Information Systems Management, Fall, 26–31.

Hall, R., 1992. The strategic analysis of intangible resources. Strategic Management Journal 13, 135–144.

Hammer, M., Mangurian, G.E., 1987. The changing value of communications technology. Sloan Management Review 28 (2), 65–71.

Harris, S.E., Katz, J.L., 1991. Organizational performance and information technology investment intensity in the insurance industry. Organization Science 2 (3), 263–295.

Hays, L., 1994. Technology: using computers to divine who might buy a gas grill. Wall Street Journal, August 16, 1

Helleloid, D., Simonin, B., 1994. Organizational learning and a firm's core competence. In: Hamel, G., Heene, A. (Eds.), Competence-based Competition. John Wiley and Sons, New York, pp. 213–240.

Henderson, R.M., Cockburn, I., 1994. Measuring competence? Exploring firm effects in pharmaceutical research. Strategic Management Journal 15, 63–84.

Hitt, L.M., Brynjolfsson, E., 1996. Productivity, business profitability, and consumer surplus: three different measures of information technology value. MIS Quarterly 20 (2), 121–142.

Hitt, M.A., Ireland, R.R., 1985. Corporate distinctive competence, strategy, industry and performance. Strategic Management Journal 6, 273–293.

Hofer, C.W., Schendel, D., 1978. Strategy Formulation: Analytic Concepts. West, St. Paul, MN.

Holsapple, C.W., Whinston, A.B., 1987. Business expert systems. Irwin, Homewood, IL.

Huber, G.P., 1991. Organizational learning: the contributing processes and the literatures. Organization Science 2 (1), 89–115.

Itami, H., 1987. Mobilizing Invisible Assets. Harvard University Press, Cambridge, MA.

Johnson, H.R., Vitale, M.R., 1988. Creating competitive advantage with interorganizational information systems. MIS Quarterly 12 (2), 153–165.

Joshi, K., 1998. Cross-functional integration: the role of information systems. Journal of Information Technology Management 9 (3), 21–29.

Keen, P.G.W., 1988. Competing in Time: Using Telecommunications for Competitive Advantage. Ballinger, New York.

Kekre, S., Mukhopadhyay, T., 1992. Impact of electronic data interchange technology on quality improvement and inventory reduction programs: a field study. International Journal of Production Economics 28, 265–282.

Kelley, M.R., 1994. Productivity and information technology: the elusive connection. Management Science 40 (11), 1406–1425.

King, W.R., Grover, V., 1991. The strategic use of information resources: an exploratory study. IEEE Transactions on Engineering Management 38 (4), 293–305.

Koelsch, J.R., 1990. 1990 lead award report: CIM for success. Manufacturing Engineering 105 (4), 29–32.

Kolodner, J., Mark, W., 1992. Case-based reasoning. IEEE Expert 7 (5), 5–6.

Konsynski, B.R., McFarlan, F.W., 1990. Information partnerships—shared data, shared scale. Harvard Business Review 68 (5), 114–120.

Lado, A.A., Boyd, N.G., Wright, P., 1992. A competency-based model of sustainable competitive advantage: toward a conceptual integration. Journal of Management 18, 77–91.

Lado, A.A., Wilson, M.C., 1994. Human resource systems and sus-

tained competitive advantage: a competency-based perspective. Academy of Management Review 19 (4), 699–727.
Lado, A.A., Zhang, M.J., 1998. Expert systems, knowledge development and utilization, and sustained competitive advantage: a resource-based model. Journal of Management 24 (4), 489–509.
Leonard-Barton, D., Sviokla, J.J., 1988. Putting expert systems to work. Harvard Business Review 66 (2), 91–98.
Li, M., Ye, R., 1999. Information technology and firm performance: linking with environmental, strategic and managerial contexts. Information and Management 35, 43–51.
Loveman, G., 1988. An assessment of the productivity impact of information technologies. MIT Management in the Nineties Working Paper: 88-054. Massachusetts Institute of Technology, Cambridge.
Lucas, H.C. Jr., 1993. The business value of information technology: a historical perspective and thoughts for future research. In: Banker, R.D., Kauffman, R.J., Mahmood, M.A. (Eds.), Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage. Idea Group Publishing, Harrisburg, PA, pp. 359–374.
Mahoney, J.T., Pandian, J.R., 1992. The resource-based view within the conversation of strategic management. Strategic Management Journal 13, 363–380.
MacDuffie, J., Krafcik, J., 1990. Integrating technology and human resources for high performance manufacturing: evidence from the international auto industry (Working Paper). Sloan School of Management, MIT, The International Motor Vehicle Program, Cambridge, MA.
Mata, F.J., Fuerst, W.L., Barney, J.B., 1995. Information technology and sustained competitive advantage: a resource-based analysis. MIS Quarterly 19, 487–505.
McFadden, R.R., Hoffer, J.A., 1991. Database Management. Benjamin/Cummings, Redwood City, CA.
McFarlan, F.W., 1984. Information technology changes the way you compete. Harvard Business Review 62 (3), 98–103.
McKeen, J.D., Smith, H.A., 1993. The relationship between information technology use and organizational performance. In: Banker, R.D., Kauffman, R.J., Mahmood, M.A. (Eds.), Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage. Idea Group Publishing, Harrisburg, PA, pp. 405–444.
Mukhopadhyay, T., Kekre, S., Kalathur, S., 1995. Business value of information technology: a study of electronic data interchange. MIS Quarterly, June, 137–156.
Neumann, S., 1994. Strategic information systems: competition through information technologies. Macmillan, New York.
Parker, C., Case, T., 1993. Management Information Systems: Strategy and Action. McGraw–Hill, New York.
Parsons, G.L., 1983. Information technology: a new competitive weapon. Sloan Management Review 25 (1), 3–14.
Peteraf, M.A., 1993. The cornerstones of competitive advantage: a resource-based view. Strategic Management Journal 14, 179–191.
Polanyi, M., 1967. The Tacit Dimension. Anchor, Garden City, NY.
Porter, M.E., 1980. Competitive Strategy. Free Press, New York.
Porter, M.E., 1981. The contributions of industrial organizations to strategic management. Academy of Management Review 6 (4), 609–620.
Porter, M.E., 1985. Competitive Advantage. Free Press, New York.
Porter, M.E., Millar, V.E., 1985. How information gives you competitive advantage. Harvard Business Review 63 (4), 149–160.
Powell, T.C., Dent-Micallef, A., 1997. Information technology as competitive advantage: the role of human, business, and technology resources. Strategic Management Journal 18 (5), 375–405.
Prahalad, C.K., Hamel, G., 1990. The core competence of the corporation. Harvard Business Review 68 (3), 79–91.
Rasheed, A.M.A., Datta, D.K., 1991. Online databases in environment scanning: usage and organizational impact. In: Szewczak, E., Snodgrass, C., Khosrowpour, M. (Eds.), Management Impacts of Information Technology: Perspectives on Organizational Change and Growth. Idea Group Publishing, Harrisburg, PA, pp. 389–407.
Reardon, J., Hasty, R., Coe, B., 1996. The effect of information technology on productivity in retailing. Journal of Retailing 72 (4), 445–461.
Reed, R., DeFillippi, R., 1990. Causal ambiguity, barriers to imitation, and sustainable competitive advantage. Academy of Management Review 15, 88–102.
Reekers, N., Smithson, S., 1994. EDI in Germany and the UK: strategic and operational use. European Journal of Information Systems 3 (3), 169–178.
Rice, R.E., Bair, J.H., 1984. New organizational media and productivity. In: Rice, R.E. et al. (Eds.), The New Media: Communication, Research and Technology. Sage, Newbury Park, CA, pp. 185–216.
Runge, D., Earl, M., 1988. Gaining competitive advantage from telecommunications. In: Earl, M. (Ed.), Information Management: The Strategic Dimension. Oxford University Press, New York, pp. 75–86.
Scala, S., McGrath, R. Jr., 1993. Advantages and disadvantages of electronic data interchange. Information and Management 25, 85–91.
Schulze, W.S., 1994. The two schools of thought in resource-based theory: definitions and implications for research. In: Shrivastava, P., Huff, A., Dutton, J. (Eds.), Advances in Strategic Management, vol. 10A. JAI Press, Greenwich, CT.
Selznick, P., 1957. Leadership in Administration. Harper and Row, New York.
Senna, J., 1997. Phantom indexes your intranet. Infoworld 19 (23), 74.
Sinkula, J.M., 1994. Market information processing and organizational learning. Journal of Marketing 58, 35–45.
Snow, C.C., Hrebiniak, L.G., 1980. Strategy, distinctive competence, and organizational performance. Administrative Science Quarterly 25, 317–336.
Srinivasan, K., Kekre, S., Mukhopadhyay, T., 1994. Impact of electronic data interchange technology on JIT shipments. Management Science 40 (10), 1291–1304.
Stalk, G., Evans, P., Shulman, L.E., 1992. Competing on capabilities: the new rules of corporate strategy. Harvard Business Review 70 (2), 57–69.
Stein, E.W., Zwass, V., 1995. Actualizing organizational memory with information systems. Information Systems Research 6 (2), 85–117.
Stroud, D., 1998. Internet Strategies: A Corporate Guide to Exploiting the Internet. St Martin's Press, New York.
Synnott, W.R., 1987. The Information Weapon. John Wiley and Sons, New York.
Tam, K.Y., 1998. The impact of information technology investments on firm performance and evaluation: evidence from newly industrialized economies. Information Systems Research 9 (1), 85–98.
Teece, D.J., 1987. The Competitive Challenge: Strategies for Industrial Innovation and Renewal. Ballinger, Cambridge, MA.
Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strategic Management Journal 18, 509–533.
Treacy, M., Wiersema, F., 1993. Customer intimacy and other value disciplines. Harvard Business Review 71, 84–93.
Turban, E., 1990. Decision Support and Expert Systems: Management Support Systems. Macmillan, New York.
Upton, D.M., 1995. What really makes factories flexible? Harvard Business Review 73 (4), 74–84.
Venkatraman, N., 1994. IT-enabled business transformation: from automation to business scope redefinition. Sloan Management Review 35 (2), 73–87.
Venkatraman, N., Zaheer, A., 1990. Electronic integration and strategic advantage: a quasi-experiment study in the insurance industry. Information Systems Research 1 (4), 377–393.
Weigelt, K., Camerer, C., 1988. Reputation and corporate strategy: a

review of recent theory and applications. Strategic Management Journal 9, 443–454.
Weill, P., 1988. The relationship between investment in information technology and firm performance in the manufacturing sector. Unpublished Ph.D. dissertation, New York University, New York.
Weill, P., 1992. The relationship between investment in information technology and firm performance: a study of the valve manufacturing sector. Information Systems Research 3 (4), 307–333.
Wernerfelt, B., 1984. A resource-based view of the firm. Strategic Management Journal 5, 171–180.
Williamson, O.E., 1985. The Economic Institutions of Capitalism. Free Press, New York.
Wilson, D.D., 1993. Assessing the impact of information technology on organizational performance. In: Banker, R.D., Kauffman, R.J., Mahmood, M.A. (Eds.), Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage. Idea Group Publishing, Harrisburg, PA, pp. 471–514.
Winter, S.G., 1987. Knowledge and competence as strategic assets. In: Teece, D.J. (Ed.), The Competitive Challenge. Ballinger, Cambridge, MA, pp. 159–184.
Yamasaki, L., Manoochehri, G. H., 1990. The commercial application of expert systems. SAM Advanced Management Journal, Winter, 42–45.
Zorn, P., Marshall, L., Paned, M., 1997. Surfing corporate intranets: search tools that control the undertow. Online 21 (3), 30–51.

Michael J. Zhang is an assistant professor in the Department of Management at the Chinese University of Hong Kong. He received his D.B.A. from the Cleveland State University. His current research in the strategic management of information technology focuses on the impact of information systems on organizational competencies, organizational learning, organizational innovation, and knowledge management.

Augustine A. Lado is an associate professor in the Department of Management and Labor Relations at the Cleveland State University. He received his Ph.D. in strategic management from the University of Memphis. Dr Lado has published in *Academy of Management Review*, *Journal of Management*, *Journal of Information Technology*, *Information Systems Management*, *Entrepreneurship: Theory and Practice*, and *Journal of Business Research*. His current research interests include IT impact on knowledge management, organizational competencies, managerial capital formation, and international strategic alliances.