

# MIS Quarterly

RESEARCH ARTICLE

## THE IMPLICATIONS OF INFORMATION TECHNOLOGY INFRASTRUCTURE FOR BUSINESS PROCESS REDESIGN<sup>1</sup>

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### Abstract

*Business process redesign (BPR) is a pervasive but challenging tool for transforming organizations. Information technology plays an important role by either enabling or constraining successful BPR. This paper explores the links between firm-wide IT infrastructure and business process change. IT infrastructure is the base foundation of the IT portfolio, which is shared throughout the firm in the form of reliable services, and is usually coordinated by the IS group. IT infrastructure capability includes both the technical and managerial expertise required to provide reliable physical services and extensive electronic connectivity within and outside the firm.*

*Exploratory case analysis of four firms (two in retail and two in petroleum) was used to understand the ways IT infrastructure contributes to success in implementing BPR. The finding was that all firms needed a basic level of IT infrastructure capability to implement BPR. The firms that had developed a higher level of IT infrastructure capabilities, before or concurrent with undertaking business process redesign, were able to implement extensive changes to their business processes over relatively short time frames. The higher level of infrastructure capability was provided in the form of (1) a set of infrastructure services that spanned organizational boundaries such as those between functions, business units, or firms, and (2) the ability of the infrastructure to reach particular constituencies inside and outside the firm to transfer information and process complex transactions.*

*The more extensive business process changes were more innovative and radical, crossing business and functional unit boundaries, and resulted in more significant business impact. The practical implication of the study is that before embarking on any form of BPR, managers should complete a business audit of their IT infrastructure capabilities, as these capabilities have an important impact on the speed and nature of business process change.*

**Keywords:** IT infrastructure, IT services, business process redesign and reengineering, business strategy, IT alignment, exploratory case analysis

**ISRL Categories:** AF0401.02, BA0208, DB01, DD0402, DD05, UF, EG

<sup>1</sup>Allen Lee was the accepting senior editor for this paper.

## Introduction

Business process redesign (BPR) is a pervasive tool for transforming organizations (Grover et al. 1993) and ranked as one of the most important issues for information systems (IS) executives since the early 1990s (Brancheau et al. 1996; Index Group 1994; Watson et al. 1996). In 1994, nearly two thirds (63%) of IS executives indicated that their companies had active process redesign projects; in 70% of these, the IS organization was part of the redesign team (Index Group 1994). Over half of the IS executives indicated that they were developing systems for redesigned processes. However, BPR is often difficult to implement, with 68% of companies encountering unanticipated problems and obstacles (Snell 1994).

According to writers on the potential effects of BPR, information technology (IT) is fundamental in enabling the innovative redesign of core business processes (Brancheau et al. 1996; Hammer and Champy 1993). IT can be a stimulus for BPR, allowing firms to break long-standing business rules (Hammer and Champy 1993; Wastell et al. 1994; Yetton et al. 1993). New IT systems can directly contribute to reducing the costs of production, coordination, and information (Earl and Kuan 1994, p. 26).

There is a well-accepted iterative relationship between the strategic context of the firm, the nature of business processes, and the significance of IT investments, both as barriers to and enablers for changing business processes (Bashein et al. 1994; Coulson-Thomas 1994; Stoddard and Jarvenpaa 1993). While IT is a potential enabler of change it is also a potential constraint or inhibitor (Benjamin 1993; Broadbent and Butler 1995; Davenport 1993; Earl 1994; Earl and Kuan 1994), particularly when the firm's IT infrastructure is inappropriate or inflexible (Brancheau et al. 1996; Wastell et al. 1994).

This paper explores the nature of the linkage between business process redesign and IT infrastructure. It demonstrates that all four firms needed a basic level of IT infrastructure capability to implement BPR. The paper also shows that those infrastructure services that spanned organizational boundaries between functions, business units

(BU), and firms provided the basis for faster and more extensive changes in business processes.

Table 1 lists the set of IT infrastructure services identified in the four firms, derived from a list of services developed in earlier research (Broadbent et al. 1996). The core services (1 through 10) were provided by all four firms, and the additional services (11 through 23) were provided by at least one of the four firms. The seven services highlighted in bold are those that span organizational boundaries.

The paper demonstrates that two of the four firms had all seven of these boundary-spanning services (the others had only three), which enabled them to implement more extensive process changes more quickly. The extensive process changes were more innovative and radical, crossed business unit boundaries and had more significant business impact.

In the remainder of the paper, the literature on the relationship between BPR and IT infrastructure is considered first. A discussion is then presented on how IT infrastructure capabilities were assessed. The four firms' business environment and drivers, process changes, major IT infrastructure investments, and IT infrastructure capabilities are described. The role of IT infrastructure in BPR is then analyzed followed by a discussion of how infrastructure enabled or constrained BPR in each firm. The paper closes with an examination of the underlying relationship between IT infrastructure and BPR, the implications for management, and conclusions from the research.

## Business Process Redesign and IT Infrastructure

Documented examples of BPR implementations indicate that the degree of business transformation varies significantly between firms and between different parts of the same firm (see, for example, Butler 1994, 1996; Caron et al. 1994; Hall et al. 1993; Stafford 1993). Improving processes usually involves implementing systems and process management across business function boundaries rather than within functions. Information technology, in the form of communications networks and shared databases, often

Table 1. Firm-Wide Infrastructure Services Needed for BPR\*

| Core Information Technology Infrastructure Services       |   |
|---|---|
| 1.  | Manage firm-wide communication network services   |
| <b>2.</b>   | <b>Manage group-wide or firm-wide messaging services</b>  |
| 3.  | Recommended standards for at least one component of IT architecture (e.g., hardware, operating systems, data, communications) |
| 4.  | Implement security, disaster planning, and business recovery services for firm-wide installations and applications            |
| 5.  | Provide technology advice and support services  |
| 6.  | Manage, maintain, support large-scale data processing facilities (e.g., mainframe operations)                                 |
| <b>7.</b>   | <b>Manage firm-wide or business-unit applications and databases</b>   |
| 8.  | Perform IS project management   |
| 9.  | Provide data management advice and consultancy services   |
| 10.   | Perform IS planning for business units  |
| Additional Information Technology Infrastructure Services |   |
| <b>11.</b>  | <b>Enforce IT architecture and standards</b>  |
| 12.   | Manage firm-wide or business-unit workstation networks (e.g., LANs, POS)  |
| 13.   | Manage and negotiate with suppliers and outsourcers   |
| 14.   | Identify and test new technologies for business purposes  |
| 15.   | Develop business-unit specific applications (usually on a chargeback or contractual basis)                                    |
| 16.   | Implement security, disaster planning, and recovery for business units  |
| <b>17.</b>  | <b>Electronically provide management information (e.g., EIS)</b>  |
| 18.   | Manage business-unit-specific applications  |
| <b>19.</b>  | <b>Provide firm-wide or business-unit data management, including standards</b>  |
| <b>20.</b>  | <b>Develop and manage electronic linkages to suppliers or customers</b>   |
| <b>21.</b>  | <b>Develop a common systems development environment</b>   |
| 22.   | Provide technology education services (e.g., training)  |
| 23.   | Provide multimedia operations and development (e.g., video-conferencing)  |

\*The bold face services are boundary crossing where they are clearly and actively integrative supporting information flows beyond one functional area. The generic list of IT infrastructure services was developed by Broadbent et al. (1996).

underpins the "architecture" of business process redesign (Earl and Kuan 1994, p. 22). In examples such as Wal-Mart (Furey and Diorio 1994) and Xerox (Ramcharamdas 1994), the role of enabling technologies was identified as integral to the successful implementation of business process redesign.

The practical options available in planning and changing processes in a BPR effort are constrained or enabled by IT infrastructure (Grover et al. 1993). The capability of the IT infrastructure is one of the most important issues facing informa-

tion systems executives (Brancheau et al. 1996). An analysis of 23 redesign projects in manufacturing firms identified infrastructure as providing increased flexibility, improved communication, and integration of different functions and organizations (Dixon et al. 1994). The availability of appropriate infrastructure capability was a key factor preceding the successful implementation of redesigned business processes (Caron et al. 1994).

IT infrastructure investments can be a constraint where systems are not compatible, or where

inconsistent data models have been used in different parts of the business. Many firms already have very significant investments in systems that are based on old or inappropriate processes, business design, or structure assumptions. Data and systems architectures (Keen 1995) built to serve local, functional needs may put limits on process integration (Earl 1994). The process-oriented architectures necessary for business process redesign emphasize "lateral data models, interfacing systems, integrating communications . . . and these can take time to build" (Earl and Kuan 1994, p. 26). The capabilities of IT infrastructure required to support these integrating capabilities crossing business and functional unit boundaries are a specific focus of this paper. A typical boundary-crossing infrastructure service is centrally coordinated and mandatory. An example of a boundary crossing service, where the boundary is the business unit, is the provision of a firm-wide customer database in a bank where the customer's entire relationship is captured and used by several IT applications in different businesses of the bank.

While the significance of IT infrastructure to business process change is now increasingly recognized, this finding is usually a by-product of BPR studies or the articulation of concerns of practitioners. Knowledge of the role of IT infrastructure capabilities remains largely "in the realms of conjecture and anecdote" (Duncan 1995, p. 39).

The implications of IT infrastructure capability are examined in this paper to discover the way in which firms commence and implement business process redesign. Specifically asked is whether the availability of IT infrastructure impacts the nature or speed of BPR implementation.

## Research Method

The links between IT infrastructure and business process redesign were examined through an exploratory case analysis of four firms. The multiple-case design was chosen to suit the objectives of description and theory building (Benbasat et al. 1987). Multiple case design is an intensive empirical research approach suited to the study of emerging and complex phenomena (Yin 1994).

The major research questions were:

1. How did IT infrastructure capabilities facilitate the implementation of BPR?
2. How did IT infrastructure capabilities constrain the implementation of BPR?
3. Which IT infrastructure capabilities have the largest impact in implementing BPR?

## Selection of the Firms

Two firms in each of two industry areas were chosen, thereby providing four organizational settings for study but limiting the influence of industry effects. A multisite case approach was chosen in order to understand the nature and complexity of the processes taking place (Benbasat et al. 1987; Eisenhardt 1989).

The firms were in the petroleum and retail industries, which both face intense competitive pressures and are heavily reliant on information technology. However, they provide a contrast in their strategic use of information and information technology (Cash et al. 1992; Porter and Millar 1985). The petroleum firms use IT predominantly in distribution, while the retailing firms use IT in all parts of the value chain from suppliers to post-sale customer service. The inclusion of these two industries was not aimed at cross-industry comparisons. Rather, the aim was to check that the phenomena were not industry-specific.

In each industry two firms were selected that

- had significant market share (over 15%);
- had completed the redesign of at least one business process; and
- had some firm-wide IT infrastructure.

The petroleum firms are referred to as CostCo and LeapCo and the retail firms as StockCo and MergeCo. The names are indicative of a major business focus of each firm.

## Data Collection

Both qualitative (e.g., open ended interviews) and quantitative (e.g., response forms with quantified responses) methods were used (Kaplan and Duchon 1988) with multiple respondents in each



firm to achieve triangulation of data and insights. Organizational documentation (e.g., memos, internal report) and presentations by senior management about the BPR initiative were also analyzed.

Each firm had a minimum of four participants, some of whom were interviewed on multiple occasions. These included the chief information officer, IS managers from at least two different business units, and a corporate executive who was able to provide a strategic perspective across the firm as a whole. In some cases, this was the chief operating officer and in others the director of Strategy. In each firm, the CIO was interviewed about the IS arrangements in the firm and the decision-making process relating to both business and IT strategy. Three different response forms were completed by the CIO, the two IS managers, and the corporate executive, followed by interviews (of one to eight hours over several meetings) with each manager to explore the issues in more depth. The contact time with each firm ranged from three months to nearly three years. Comparable data were obtained on each firm's investments in IT over the past five years and the rationale for their investments. The Appendix contains further details on the type and sources of data gathered from the firms.

### **IT Infrastructure Capabilities**

IT infrastructure is defined as the base foundation of the IT portfolio (including both technical and human assets), shared throughout the firm in the form of reliable services, and usually coordinated by the IS group (Broadbent et al. 1996; McKay and Brockway 1989; Weill et al. 1996). The IT infrastructure capability includes both the technical and managerial expertise required to provide reliable services. Because it can be shared across boundaries and because it can enable better business processes, IT infrastructure is different from other IT investments and applications that directly perform business processes in a particular functional area or business unit.

The IT infrastructure capability of each firm was assessed using three measures:

- **The extent of the firm's infrastructure services:** The number of infrastructure services in

each firm were measured using the list of 23 firm-wide services identified in Broadbent et al. (1996) (see Table 1). A high number of services in a firm indicates a high level of firm-wide IT infrastructure capability. For example, most firms with any shared infrastructure provide corporate communications network services and firm-wide messaging. However, some firms also conducted business transactions through EDI capability on that physical network. In addition, some firms managed the enforcement of IT architecture and standards, and provided a common systems development environment as a firm-wide service.

- **The provision of boundary-crossing infrastructure services:** By definition, all infrastructure services are shared and available to all business units in the firm. A subset of the infrastructure services is identified as boundary-crossing where they are clearly and actively integrative, supporting information flows and transaction processing beyond one functional area. Typically these boundary-crossing services are mandatory rather than optional and are used by or influence multiple IT applications across the firm (see Table 1). These services were posited as particularly important in achieving the integrative and "end to end" objectives of BPR (Davenport 1993; Hammer and Champy 1993). For example, development of online linkages to customers or suppliers (Table 1, service 20) is a boundary-crossing service where the boundary is the firm. Taken together, these services provide a strong basis for implementing cross-business and cross-functional systems more rapidly. All seven boundary-crossing services provide a common and standard electronic bridge across the boundaries, between the functional areas, business units, or firms. It is posited that firms, without these services, will experience difficulties and delays in implementing systems supporting cross-functional reengineering efforts due to the lack of a common systems platform.
- **The firm's reach and range:** The business scope of firm-wide IT infrastructure can be defined in terms of "reach and range" (Keen 1991). An extensive reach and range is illustrated in Figure 1, at point A. Here the firm is able to simultaneously perform transactions on

multiple applications updating all databases across different business units, wherever they are located. For example, in a Japanese firm with this level of reach and range, an overseas business unit could take an order and process it through inventory, production, scheduling, and eventually accounts receivable, while automatically updating the corporate executive information system back in Japan. A large reach and range indicates that the firm has a high level of IT infrastructure capability. A small reach and range would support the sending of standard messages within a single business unit location, as indicated at point B in Figure 1. The shaded area indicates the average reach and range from a group of 27 firms (Weill and Broadbent 1998, p. 262).

The motivation for, and nature of, process changes in the four firms, their IT infrastructure

investments and capabilities, and the role of these capabilities in implementing BPR are now compared. A summary of the BPR implementation and IT infrastructure capabilities in each firm is presented in Table 2.

**Process Changes and IT Infrastructure Investments**

CostCo and LeapCo are direct competitors as major refiners and marketers of petroleum products. Each has over 15% share of the domestic market and revenue in excess of U.S. \$1 billion. Although they have many similarities, the strategic intents (Hamel and Prahalad 1989, 1994) of these two firms are different, leading to different emphases in undertaking BPR. CostCo clearly identifies the need for cost consciousness, while LeapCo is more expansionary and ambitious in its aims to leap ahead into new business directions,

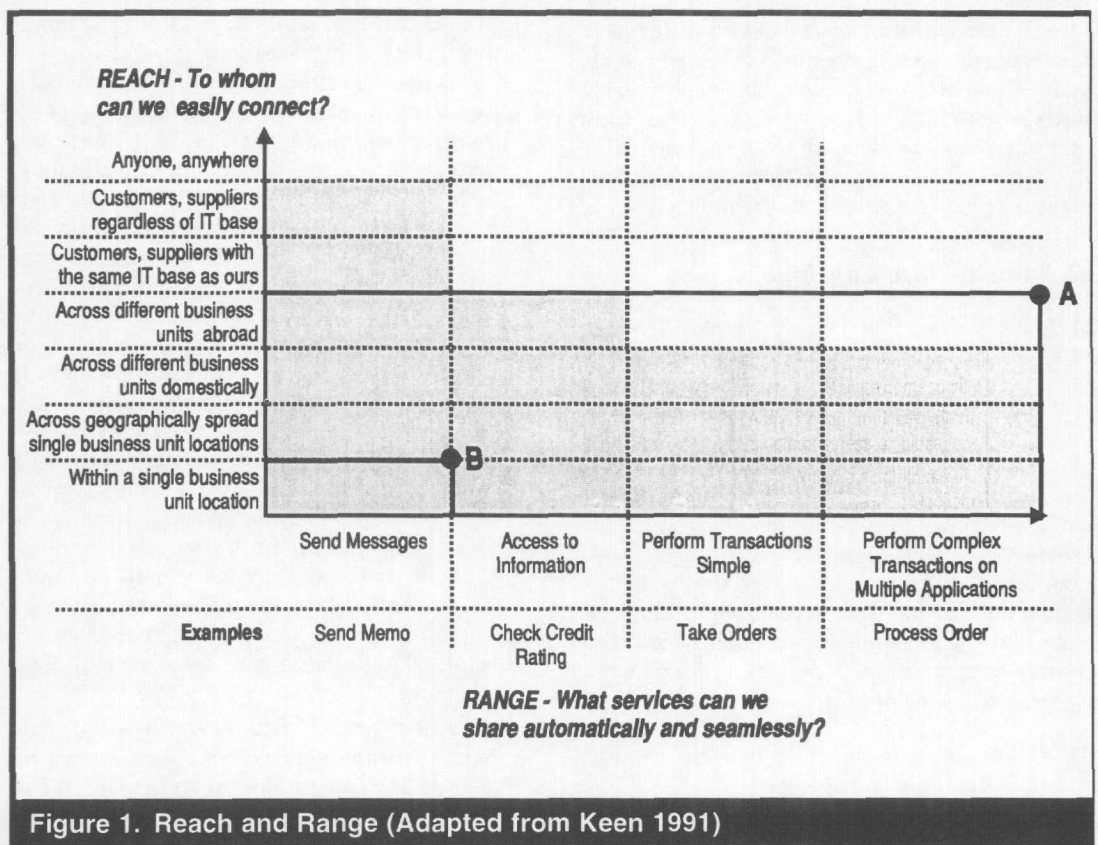


Figure 1. Reach and Range (Adapted from Keen 1991)

Note: Shaded area represents average firm reach and range.

Table 2. BPR Implementation and IT Infrastructure Capabilities

|                       |                  | Petroleum   |  |  | Retail   |  |  |
|-----------------------|------------------|---|--|--|--|--|--|
|                       |                  | CostCo  | LeapCo   | StockCo  | MergeCo  |  |  |
| Business Drivers      | Business Context | Customer responsiveness<br>Build relationships with suppliers<br>Cost conscious           | Provide services for mobile customers<br>Respond to all phases of the value chain<br>Differentiate through quality and service                         | Flexibility to accommodate change<br>Capacity to process information<br>Fast supplier links<br>Synergy for economies of scale<br>Continuous margin increases | Customer anticipation and response<br>Know what is selling and where<br>Manage at the SKU level<br>Expand product range at marginal cost |  |  |
|                       |                  | Reduce costs in tight market<br>Maintain profitability<br>Move to Customer Responsiveness | Continuing need to reduce costs<br>More radical gains sought after best practice<br>Rethinking of core business<br>Leverage infrastructure investments | Improve competitive position<br>More efficient replenishment cycles<br>Reduce inventory costs  | Merger situation: new practices needed<br>Necessary to meet strategic vision   |  |  |
| Processes Involved    | Process Changes  | Billing, Procurement, Supply<br>Other process change ongoing                              | Finance Services, Managing Investments, Developing Systems<br>Implementing all new processes based on detailed process map                             | Limited focus in Premium Stores:<br>Ordering, Stock Replenishment  | All new processes, including Buying, Financial Management, Stock Replenishment   |  |  |
|                       |                  | Reduced cost of defects<br>Improved customer focus<br>More efficient processes            | Rapid developments of revenue-based services<br>Accelerated development of business IS<br>New business opportunities                                   | Faster basic stock replenishment<br>Closer relationships with selected suppliers<br>Streamlined distribution   | Better use of stock, stores staff<br>Managing by information<br>New business opportunities   |  |  |
| Time Frame of Changes |                  | All processes between 1991 and 1995   | All processes between 1992 and 1994  | One major process between 1991 and 1995  | All processes between 1992 and 1994  |  |  |



Table 2. BPR Implementation and IT Infrastructure Capabilities (continued)

|   |   | Petroleum  |   |   | Retail   |  |  |
|---|---|--|---|---|--|--|--|
|   |   | CostCo   | LeapCo  | StockCo   | MergeCo  |  |  |
| Major Infrastructure Investment                         | Infrastructure Capabilities: Number of Services | Ongoing adjustments<br>Enhanced communication networks<br>Links to sites and supplies        | All systems renewed in 1990-1991<br>Common database management system<br>Upgraded telecommunications Support service for systems development<br>Common project management systems | Communications backbone<br>Firm-wide expertise development<br>Firm-wide EDI capability<br>Stimulated local infrastructure investment case | Greenfield site: all new systems, 1991-92<br>Hardware, software, communications network, expertise |  |  |
|   |   | Medium<br>15 of 23 Services<br>Three boundary-crossing services                              | High<br>20 of 23 Services<br>Seven boundary-crossing services   | Medium<br>15 of 23 Services<br>Three boundary-crossing services   | High<br>22 of 23 Services<br>Seven boundary-crossing services                                      |  |  |
| Role of Infrastructure                                  | Infrastructure Capabilities: Reach and Range    | Average<br>Reach: Medium<br>Range: Low   | High<br>Reach: High<br>Range: High  | Average<br>Reach: High<br>Range: Low  | High<br>Reach: High<br>Range: High   |  |  |
|   |   | IT infrastructure and systems capabilities adequate for simplification of existing processes | New IT infrastructure installed<br>Process changes leveraged from the infrastructure capability   | Firm-wide infrastructure enabled process change to commence<br>Inadequate BU infrastructure capability presented implementation barrier   | New IT infrastructure provided the basis for radical change to core processes                      |  |  |
| Relationship Between Infra-Structure Capability and BPR | Impact of IT Infrastructure Capabilities        | NEUTRAL<br>Existing capability extended  | ENABLING<br>Business changes utilized infrastructure capabilities   | DELAYED and HINDERED<br>Major new infrastructure capability needed  | ENABLING<br>Business changes and infrastructure implementation were linked and iterative           |  |  |
|   |   |  |   |   |  |  |  |



articulating the need for increasing participation in customers' value chains.

StockCo and MergeCo are both nationally operating retail firms; however, they differ in size, scope, and product range. StockCo is a large retailer and operates several retail business units with chains of both premium and low cost stores. In this study, BPR was examined by focusing on the stock replenishment cycle in the Premium Stores business unit that has revenue of over U.S. \$1 billion. The business drivers of StockCo are the increasing information needs of the retail industry, flexibility to accommodate change, linking with suppliers, economies of scale, and margin increases. MergeCo has a turnover of over U.S. \$450 million with over 300 stores nationally in the leisure and consumer markets. MergeCo aims to be a dynamic speciality retailer developing with, and responding to, the changing needs of customers. To be successful, MergeCo depends on anticipating changing customer needs, understanding buying patterns, and modifying their product range accordingly without increasing costs.

### **CostCo**

The trigger for CostCo's BPR was the need to dramatically reduce costs in order to maintain profitability in a shrinking market. In July 1991, CostCo commenced a BPR activity, named East-West. "We were convinced that we could make considerable gains through taking a process rather than a functional approach to the business," recalled the BPR project director. "Our initial goal was to focus on the order management cycle which is a microcosm of everything that we do." The order management cycle included handling customer orders, billing and payments, and fulfilling customer orders. In the early 1990s, each of these areas was treated as a separate business process, each handled by a different part of the business unit. The processes were completed sequentially, and if customers had problems in any part of the cycle, they had to identify which group within CostCo was dealing with that part of the order management cycle. East-West was seen as a project that would better integrate CostCo's Australian and New Zealand oil businesses that had recently been colocated in the firm's reporting arrangements. CostCo

focused initially on one major, but disparate, process motivated by positioning and a "crisis of opportunity" as opposed to a "crisis of survival" (Ramcharamdas 1994).

In the early 1990s, CostCo took a more business-focused approach to its IT investments. Major investments at the corporate level were of an incremental nature, particularly aimed at strengthening communications networks among commercial, retail, and manufacturing sites and suppliers. CostCo has a robust network with numerous LANs in place at its head office, in large cities, and other major sites. "About 2,000 PC users have whatever multihost connectivity is required for their business needs. We have moved from computer-centric to network-centric computing," noted the CIO. Business units utilized these networks as a basis for a new distributorship, retail and electronic funds transfer, and point of sale (EFTPOS) systems. At the commencement of the BPR, there was a concern about the long term suitability of the IT infrastructure of CostCo. IT infrastructure investments were argued on the basis of clear cost savings, or, if part of the customer interface, delivery of higher levels of customer service.

### **LeapCo**

LeapCo's motivation for BPR followed an improvement program in the late 1980s to identify best practice performance in their refineries. LeapCo implemented a program of improvements resulting in the reorganization of operations, reduced layers of management, shorter communication chains, and elimination of duplicate processes. In 1992, the benefits of the improvements program were reflected in a 23% increase in production at the refineries, but LeapCo's financial situation continued to deteriorate. Major inefficiencies remained, and part of the reason was that "the organization failed to fundamentally change the way we do business," in the view of the director of Corporate Services. The acquisition of crude oil, refining, estimates of refined products needed, sales to commercial outlets, and services to consumers at retail outlets were each treated as discrete business processes with their own planning approaches, timeframes, customer set, and underlying support systems. While each part of the business

had made efficiency gains, further gains and a more radical approach were seen as necessary. A business process reengineering group was formed and charged with modeling, challenging, and renewing all business processes to ensure the firm was managed in the most efficient and effective manner across all processes. LeapCo took a blank sheet approach aimed at implementing new processes across all major business areas.

In the late 1980s, LeapCo embarked on a major IT infrastructure investment program. At the time, the motivation was a belief that success in the 1990s would require better deployment of emerging technologies, particularly telecommunications. "Investing in IT infrastructure in the late 1980s was a leap of faith," recalled the CIO, "but the competitive edge we gained must continue to be exploited, otherwise the investment will have failed." The investment involved implementing a common database management system, an upgrade of the telecommunications platform, the creation of a support service for staff developing strategic systems, and the development of a common project management system. The IT infrastructure investments were made ahead of the current business strategies as these were "really still evolving." The investments "facilitated our more rapid development of revenue-based services and accelerated the development of business systems," according to the IS manager in the Fuels business. Technology was viewed as a key factor in providing a flexible base upon which new business opportunities were created.

### **StockCo**

In the late 1980s and early 1990s, StockCo's Premium Stores business found it increasingly difficult to compete with mass merchandizers engaging in "market creep" and with the entry of specialist stores at the top end of their market. In July 1991, the Premium Stores business unit started a pilot of EDI with selected trading partners. "We realized the importance of linking EDI initiatives to Quick Response (QR), and then saw our task as redesigning the replenishment cycle from sale through to restocking," explained the manager of the implementation team. The aim was to utilize the information provided by

EDI/QR to dramatically improve efficiency and competitiveness in local production and delivery. The focus was the order replenishment cycle that, at the time, consisted of a series of discrete processes with many steps and authority levels. For example, sales staff made estimates of instore requirements based largely on manual counts and historical rules of thumb. Head office buying staff for the specific merchandize area reviewed these estimates based on their personal knowledge and experience, and these estimates were then further reviewed by senior category managers. Suppliers were contacted and given relatively open-ended time frames for supply. Stock was handled several times at warehouses, distribution centers, and stores. For even standard stock, such as underwear and hosiery, the minimum resupply period was over 30 days. While StockCo started BPR with just one major process, their goal was ambitious in terms of completely rethinking their elongated replenishment cycle.

As a result of firm-wide and business-unit planning in StockCo in the late 1980s, a set of key requirements for IT were articulated drawing on StockCo's business drivers. These requirements included

flexibility, connectivity, synergy for economies of scale, growth without corresponding cost growth, reliability and vendor independence, centralized management where this would result in lower costs, and positioning for new services and new technologies.<sup>2</sup>

StockCo identified a communications backbone accessible by all businesses as critical for future retail systems. In describing StockCo's situation, the CIO explained:

We were an early mover into EDI, and the Corporate Information Systems (CIS) group provided the initial focus, expertise, and contacts for EDI for the business units. Our communications network investment provided the infrastructure for rapid and reasonably consistent EDI implementation across the businesses.

The benefits of investment in IT infrastructure were related to the cost savings from sharing as

<sup>2</sup>Extract from StockCo's IT Infrastructure Planning documentation.

well as flexibility required to meet the future retail environment. According to the CIO, "We value flexibility as it provides us with an advantage in the retail industry as well as lowering the cost of doing business." Firm-wide infrastructure provided a backbone service to be utilized by each business as it saw fit.

### **MergeCo**

MergeCo's acquisition of two additional store chains and their integration of the acquired and existing businesses almost doubled its size and presented major management challenges. The chief financial officer explained that

virtually all our business processes were manual, labor intensive, and prone to inaccuracies. We had no way of gaining accurate and timely information from stores to manage and control the business. We did know our acquired businesses were performing poorly, but we had a six-week delay in that information getting to us.

All stock assessments, forward purchasing of new items, orders, and replenishment were done manually. Invoice details were keyed into MergeCo's basic financial software on a batch basis. MergeCo aimed to redesign all processes throughout the firm concurrently with the implementation of their first significant investments in IT infrastructure and applications. "We recognized the urgent need for an IT infrastructure to provide the basis for new retail systems and the concurrent need to redesign our processes across all businesses." From an IT infrastructure perspective, MergeCo was a "greenfield" site and thus had no legacy systems to integrate.

In 1991, MergeCo commenced major investment in information technology, particularly IT infrastructure. The CIO emphasized the link between MergeCo's vision and the IT investments:

In 1990, the Board and executives developed a vision of where they wanted the firm to be. They accepted that integral to that vision was information. We had expanded through the acquisition of two national retail

chains and were expanding geographically in the consumer electronics areas.

The CFO emphasized the importance of information:

We needed information to run the business and to deliver that information we needed to invest heavily in information technology. Changes in the business computer systems were aimed at achieving that vision.

MergeCo's commitment to IT infrastructure in 1991 was in response to the need for accurate information in an expanded business. While the initial investment focus was survival and management control, this shifted with the realization of the business benefits to be gained from extensive and detailed customer and product information at the Stock Keeping Unit (SKU) level, (i.e., details of each unique item sold including color, size, and style). MergeCo's investments in IT infrastructure capability were substantial.

### **Summary**

The four firms differed significantly in the initial breadth of their process changes. While CostCo and StockCo commenced with one process, LeapCo and MergeCo decided to design and implement many new processes across the businesses. CostCo differed from the other three firms by having relatively modest ambitions regarding size of the changes sought. CostCo sought to simplify business processes, while StockCo, LeapCo, and MergeCo sought radical change in one or more business processes.

### **Extent of IT Infrastructure Capabilities**

All four firms provided a substantial firm-wide infrastructure capability. When compared to a sample of 27 firms (with an average of 16 IT infrastructure services; Weill and Broadbent 1998, p. 94), the four firms in this study each had at least 15 services and at least an average reach and range (see Figure 1). Each firm had the ability to send electronic messages to all business units and the ability to perform transactions across business units for at least one application. The extent and nature of each firm's infrastructure services is presented in Table 3.



Table 3. IT Infrastructure Services in the Firms

| CostCo | LeapCo | StockCo | MergeCo | Prototypical Firm-Wide IT Infrastructure Services   |
|--------|--------|---------|---------|---|
| •      | •      | •       | •       | 1 Manage firm-wide communication network services   |
| •      | •      | •       | •       | 2 <i>Manage group-wide or firm-wide messaging services</i>  |
| •      | •      | •       | •       | 3 Recommend standards for at least one component of IT architecture (e.g., hardware, operating systems, data, communications) |
| •      | •      | •       | •       | 4 Implement security, disaster planning, and business recovery services for firm-wide installations and applications          |
| •      | •      | •       | •       | 5 Provide technology advice and support services  |
| •      | •      | •       | •       | 6 Manage, maintain, support large-scale data processing facilities (e.g., main-frame operations)                              |
| •      | •      | •       | •       | 7 <i>Manage firm-wide or business-unit applications and databases</i>   |
| •      | •      | •       | •       | 8 Perform IS project management   |
| •      | •      | •       | •       | 9 Provide data management advice and consultancy services   |
| •      | •      | •       | •       | 10 Perform IS planning for business units   |
|        | •      |         | •       | 11 <i>Enforce IT architecture and standards</i>   |
| •      |        |         | •       | 12 Manage firm-wide or business-unit workstation networks (e.g., LANs, POS)   |
|        | •      | •       | •       | 13 Managing and negotiating with suppliers and outsourcers  |
|        |        | •       | •       | 14 Identify and test new technologies for business purposes   |
|        | •      | •       | •       | 15 Develop business-unit specific applications (usually on a chargeback or contractual basis)                                 |
| •      | •      | •       | •       | 16 Implement security, disaster planning and recovery for business units  |
|        | •      |         | •       | 17 <i>Electronically provide management information (e.g., EIS)</i>   |
|        | •      |         | •       | 18 Manage business-unit-specific applications   |
|        | •      |         | •       | 19 <i>Provide firm-wide or business-unit data management, including standards</i>   |
| •      | •      | •       | •       | 20 <i>Develop and manage electronic linkages to suppliers or customers</i>  |
|        | •      |         | •       | 21 <i>Develop a common systems development environment</i>  |
| •      | •      |         | •       | 22 Provide technology education services (e.g. training)  |
| •      |        |         |         | 23 Provide multimedia operations and development (e.g., video-conferencing)   |

**Note:** Shaded services are boundary crossing.

The firms differed in their infrastructure capability in the following ways:

- CostCo had a substantial level of IT infrastructure capability with 15 of the 23 services available, and with reach and range comprising an "anyone, anywhere" reach, but limited range with the ability to perform only simple transactions across a small number of applications.
- LeapCo had extensive IT infrastructure capabilities with a high number of infrastructure services (20) and an above average reach and range with the ability to perform complex transactions on multiple applications across business units.
- StockCo had substantial IT infrastructure capabilities with 15 of the 23 services available. StockCo differed from CostCo in having centralized negotiations with information technology suppliers and the central identification and testing of new retail technologies. StockCo's reach was high, but range was limited in the type of transactions that could be processed across multiple applications.
- MergeCo had a high level of IT infrastructure capability with extensive infrastructure services (22). MergeCo had a higher than average reach and range, including the ability to perform multiple transactions across all applications across all business units.
- All four firms provided three of the seven boundary-crossing infrastructure services with only LeapCo and MergeCo having all seven.

The infrastructure services that differentiate the two groups of firms are enforcement of IT architecture and standards, electronically provide management information, firm-wide data management, and development of a common systems development environment. These boundary-crossing services exist in LeapCo and MergeCo and not the other two, thus enabling cross-boundary applications to be implemented more quickly and easily in LeapCo and MergeCo than in CostCo and StockCo. The role of these IT infrastructure capabilities in contributing to BPR implementation is described in the next section.

## The Role of IT Infrastructure Capabilities in Implementing BPR

The key features of the progress of BPR implementation, the extensiveness and time frame of the process changes, and the interaction between BPR and infrastructure capabilities were examined (see Table 2). The salient features of each firm's BPR implementation in the context of their IT infrastructure capabilities are now compared.

### CostCo

The first phase of East-West, from mid-1991 to early 1992, was primarily a learning exercise for CostCo, with the identification of the potential business benefits from reconfiguration of the order management cycle. From March to September 1992, a small team further examined process approaches concurrently with a detailed study of the capabilities of the firm's current systems and infrastructure. In Phase 3 (October 1992 to April 1993), a high level process map was completed. CostCo found it essential to have agreement on a high level process map before the redesign of specific processes began. The billing process became the focus of the redesign effort and detailed plans were developed to reconfigure billing arrangements and instigate cross-functional management approaches for that process. The new billing process was implemented, with the cost of the process being substantially reduced, and the time taken to handle customer queries reduced from three days and four handovers to three minutes (maximum) with no handovers. CostCo then commenced analysis of the procurement process and the refining supply process. CostCo had redesigned almost all of its major processes four years after commencing BPR and was well advanced in implementation.

CostCo's changes focused largely on existing processes and the firm made incremental changes to its IT infrastructure. During the billing redesign process, "business managers found that, surprisingly, the changes they sought were possible with the existing systems infrastructure," recalled the BPR project director. Information

about additional system features had been lost from corporate memory due to staff cuts, lack of documentation, and movement of staff. CostCo's modest firm-wide IT infrastructure did not hinder the BPR.

### **LeapCo**

LeapCo developed a detailed process map linking 17 major processes grouped into three areas: management, operational, and organizational infrastructure. These processes were divided into over 200 subprocesses. The process mapping activities drew on, and benefited from, expertise gained in developing a detailed business information model as part of the previous IT infrastructure implementation. The process of developing information systems was redesigned with a fourfold increase in productivity.

Redesign of the customer financial service process provides an example of the nature of the changes in LeapCo. This process was completely redesigned through the development of a Customer Service System (CSS). Customers using the CSS pay for a variety of purchases with a wide choice of credit and debit cards. LeapCo earns a significant and growing amount of revenue from their franchisees and card providers for the use of the CSS. This system was extended in the mid-1990s to include acceptance of cards from another major petroleum retailer, leading to possible future alliances. LeapCo captures details of sales by petrol pump and transmits the data via the network to the central mainframe where the data are analyzed. In the very price-volatile petroleum market, the system has enabled LeapCo to revise its retail petrol pricing process by monitoring petrol pump prices and responding to petrol discounting by other oil companies.

The changes LeapCo made to its business processes were dramatic and innovative both for the firm and the industry. LeapCo's extensive cross-functional and cross-business unit IT infrastructure capabilities such as the electronic provision of management information (Table 3, service 17), firm-wide data management (service 19), and development of a common systems development environment (service 21) provided the building blocks for faster development of new and cross-functional business processes and

applications such as petrol pricing. These cross-functional infrastructure capabilities provided a powerful base for LeapCo's highly cross-functional BPR initiatives. In the mid-1990s, LeapCo merged with a competitor. Although LeapCo was the junior partner in the merger, its systems were implemented throughout the merged company and provide the basis for further merging of business processes.

### **StockCo**

In mid-1992, the Premium Stores business of StockCo completed the first stage of its EDI/QR initiative, a project ultimately designed to considerably shorten the stock replenishment cycle and to reduce costs associated with holding inventory. Successful implementation of EDI/QR required a major redesign of a key business process in Premium Stores. However, the further extension of the project stalled as the infrastructure of the Premium Stores group was unable to cope with the new requirements. The initial business case for the EDI/QR initiative did not consider adequately the infrastructure capabilities necessary for implementation, particularly the complete consistency and intensity of data management required across all systems. Multiple sales, financial, ordering, and distribution systems dealt with different aspects of triggering and completion of the stock replenishment process. The current infrastructure, with its lack of data consistency, multiple systems, and lack of processing capacity at store level presented barriers to implementing all phases of the redesigned process. Business managers did not at first appreciate the significant ramifications of the planned process changes for their systems (for example, to process tens of thousands of products at the stock-keeping unit (SKU) level for the first time). The lack of cross-functional consistency and processing capacity hindered implementation. The replenishment cycle was reduced from over 30 days to less than 20 days with some incremental changes to both systems and work practices. However, the ideal of less than five days could not be achieved until extensive infrastructure investments were implemented along with the new business processes. This included renewal and integration of multiple systems, a new focus



on consistent data management, and an increase of data processing capacity at the store level.

StockCo's infrastructure required extensive upgrading to provide the basis for successful implementation of a redesigned process. StockCo subsequently developed a new technical plan, completed extensive data architecture work, including the identification of core data elements and data dictionary definitions. A new generation of store-level technology is now required to gather and process data from stores to headquarters. The delays in the implementation have highlighted to StockCo's business executives the intimate link between the demands of radical new business processes and IT infrastructure capability. This link was not appreciated before the process change stalled. Subsequent infrastructure business cases have received strong business support, particularly after StockCo's competitive position declined further.

### **MergeCo**

MergeCo radically changed all of the firm's business processes in less than two years from almost completely manual processes to completely integrated IT-supported processes. Information from point-of-sale and management information systems provided the basis for completely new retailing and management strategies. All buying was centralized, which gave the firm considerable power in price negotiations and in the quality of products selected.

Customer information allowed constant tracking of buyer behavior and provided the ability to predict trends in the marketplace. Stores were redesigned to meet customer and product needs that were identified using the higher quality information available to management. The nature of work undertaken by store managers changed drastically, freeing up to two thirds of their time for customer-related and selling activities. As the chief operating officer explained,

Our store managers used to spend about one-third of their time on inventory and order management and another third on administration. These are now handled centrally with less paperwork, more efficient audit control of stores, reduced inventory,

and greater stock turns. It has also assisted with our staffing at the local level. Staff can be more effectively rostered, based on our known peak demand periods.

Electronic links with suppliers are becoming increasingly important to improve inventory control and reduce buying and storage costs.

The role of IT infrastructure was initially envisaged as facilitating business process changes. However, this moved to transforming the business processes as the new systems were planned and implemented. MergeCo's infrastructure capabilities were extensive and provided the base for radical change to core business processes.

## **IT Infrastructure Capabilities Constraining and Enabling BPR ■**

The role of IT infrastructure in the implementation of BPR in the four firms is summarized here. IT infrastructure capabilities played one of three roles:

- In CostCo, the infrastructure assisted simplification and streamlining of business processes and did not hinder redesign.
- In StockCo, parts of the infrastructure provided both a sophisticated network and the capacity to commence business process redesign. However, other parts of the infrastructure hindered implementation, extending the time and initially reducing the scope of the changes that were possible. For example, StockCo's lack of the boundary crossing service "Enforce IT architecture and standards"(Table 3, service 11) resulted in no data consistency across functions. This inconsistency meant that much-needed data about what was selling could not be readily integrated with ordering and logistics systems. Development of a data architecture was required to provide a foundation for cross-functional systems that could then process and exchange data across systems.
- In LeapCo and MergeCo, IT infrastructure provided building blocks of capability and stimulated and enabled implementation of radical new business processes. Extensive boundary-

crossing infrastructure services and high reach and range enabled speedier implementation of cross-functional and cross-business processes.

The experiences of these four firms highlight aspects of the relationship between IT infrastructure and BPR. The scope and depth of process changes were greater in the two firms with more extensive infrastructure capability. These experiences identify the role of IT infrastructure as potentially either an implementation barrier or enabler to BPR.

The following conclusions are drawn from the analysis of the firms:

- 1. All four firms had infrastructure capabilities that allowed implementation of some type of BPR.** All firms had a substantial set of infrastructure services, including communication networks, standards for at least one component of IT architecture, and management of some firm-wide applications and databases (see Table 3). All firms also had some form of online or EDI linkage to suppliers or customers (Table 3, service 20).
- 2. All four firms had experience in creating boundary-crossing capabilities.** Both infrastructure and BPR are cross functional in nature and thus have natural synergies. Both require a management perspective that is broader than one function or one business. This perspective is evidenced by designing and funding IT infrastructure services such as the firm-wide electronic provision of management information (Table 3, service 17), the enforcement of IT architecture and standards (service 11), and a reach and range which enables the performance of complex transactions across multiple business units. The conclusion is that the boundary-crossing services (shaded areas of Table 3) are particularly important in enabling BPR. It is posited that the lack of such infrastructure services will be a potential barrier to implementation of BPR.
- 3. Infrastructure range that crosses business unit boundaries is important for BPR.** The four firms studied all had extensive infrastructure reach and could generally send messages and access stored data across that reach. However, the firms that completed more
- 4. Two different types of BPR were identified: process simplification and process innovation.** Process change based on *simplification* of existing processes required at least a medium level of infrastructure services and a reach and range suitable to provide some of the cross-business and cross-functional systems that BPR typically requires. The implementation of radically redesigned processes, *process innovation* (Davenport 1993; Stoddard and Jarvenpaa 1995) was facilitated by extensive IT infrastructure capabilities with a high number of infrastructure services and high reach and range extending across functions and business units. Businesses were able to integrate their processes through the ability to perform complex transactions across the firm. This conclusion is illustrated by examples from the firms:
  - The corporate IS group in StockCo laid the foundation for extensive infrastructure capability through its communications infrastructure investments in the late 1980s. This provided the initial capability for the StockCo business units to commence business process change in the early 1990s. Premium Stores drew on this communications infrastructure to commence implementation of EDI/QR aimed at substantial changes to the replenishment cycle. The successful implementation of the changes could not be achieved until major aspects of the business unit's IT infrastructure were redeveloped. The time delay meant that even more radical and extensive changes to IT infrastructure were eventually necessary due to StockCo's worsening financial situation and

the advances made by competitors. StockCo's desired process innovation was limited to simplification until the business unit's IT infrastructure was redeveloped. Process innovation was only possible after the BU infrastructure was in place.

- LeapCo and MergeCo undertook major changes to their IT infrastructure before or during BPR. The infrastructure played a key role in their ability to implement innovative process changes as IT infrastructure provided the building blocks for transforming processes. LeapCo invested in IT infrastructure in the late 1980s as a "leap of faith" driven by strategic intent and a belief that business in the 1990s would require more effective use of IT. LeapCo's BPR exploited their infrastructure capability via innovative process change. For MergeCo, the IT infrastructure investment was initially seen as a matter of business survival. Without the infrastructure investment, managers lacked the controls needed for basic information to manage an expanded business. The implementation of MergeCo's IT infrastructure interacted with BPR initiatives, thus enabling innovative process changes.

This conclusion is consistent with studies of the nature of BPR implementation. Less than half of those undertaking BPR consider that they are undertaking radical innovation (Butler 1996; Caldwell 1994). In some instances, there is both innovation and simplification in the one firm (Chita 1996) with "simplification only" accounting, in different studies, for between 28% (Butler 1996) and 58% (Caldwell 1994) of BPR initiatives. In a *process innovation* approach, the business is analyzed to determine what the business processes should be and a new process map constructed (Hammer and Champy 1993, p. 118). A *process simplification* approach is more limited in scope, often focusing initially on one major existing process and areas touching this process. The change tactics in process simplification are more likely to be evolutionary, while those in process innovation would be expected to be revolutionary (Stoddard and Jarvenpaa 1993).

Both the *process simplification* and *process innovation* observed in this study meet the cri-

teria for radical (as opposed to routine) innovation (Nord and Tucker 1987) in that both are new to the firms and require significant changes in the behavior of employees and in the structure of the firms. The less radical approach of process simplification can offer firms the potential to capture some of the performance advantage while minimizing risk factors (Craig and Yetton 1992). One of these risk factors is significant further investment in IT infrastructure.

5. **Process simplification requires less infrastructure capabilities because the process changes are limited in scope.** In our examples of process simplification, the supporting information systems applied to only a limited range of data types and involved a small number of applications, thus putting less demands on the IT infrastructure. The number of application system interface changes required to integrate different functions were limited. While still complex to implement, they could be accomplished within the scope of a single application maintenance project.
6. **Process innovation requires more infrastructure capabilities because the process changes are more pervasive across the firm.** Implementing process innovation involves more extensive agreements about architecture and standards, a greater range of data to be processed, a larger number of applications, and depth of consistency in work practices across functions and/or businesses. These capabilities are reflected in the seven boundary-crossing infrastructure services (shaded in Table 3) that LeapCo and MergeCo had in place, only three of which were in place at CostCo and StockCo. Process innovation requires a larger reach and range, particularly the capability to process complex transactions (i.e., involving multiple system platforms) across a single business unit, across multiple sites, and across multiple business units.
7. **Infrastructure capability has an impact on successful BPR implementation.** LeapCo and MergeCo did not encounter significant IT infrastructure implementation barriers in their BPR implementation. They were able to dramatically redesign business processes and imple-



ment those changes. There is also evidence that the capabilities of the infrastructure facilitated more radical changes. CostCo's aspirations for BPR were limited, and these aspirations were achievable with incremental changes to their IT infrastructure. StockCo's BPR aspirations were thwarted by the limitations of the IT infrastructure in place, and their implementation stalled.

This conclusion is supported by longitudinal work by Stoddard and Jarvenpaa (1995) clarifying the two stages of BPR and the different approaches used: i.e., revolutionary vs. evolutionary. The first stage is the design or blueprint for change and the second stage is the implementation of those plans. The research presented in this paper is consistent with their findings in emphasizing the role of IT infrastructure as an enabler or constraint in implementation. Their observations can be extended to suggest where the design was innovative; infrastructure can be one of the barriers that then requires a more evolutionary implementation.

### Summary

This work illustrates that firms with an extensive set of infrastructure capabilities, such as evident in LeapCo and MergeCo, experience fewer technological barriers to BPR implementation. Extensive infrastructure services enable BPR, particularly those services crossing organizational boundaries such as firm-wide IT architectures and standards, firm-wide data management, and a common systems development environment. These services enable BPR by providing a strong base for the processing and exchange of consistent data and thus taking a process, rather than a task, perspective across and between businesses. The ability to process complex transactions across a business unit with multiple sites as well as multiple business units is also a strong enabler for BPR.

### Limitations of the Study

There are a number of limitations to the findings of this study including:

- The findings were based on a limited number of firms studied over a limited period.
- The difference in up-front and total costs of providing IT infrastructure capabilities was not addressed. However, there is evidence that more extensive infrastructure capabilities require considerably higher levels of IT investment over time (Keen 1991; Weill and Broadbent 1998).
- The paper focused on the IT issues and did not address the other factors necessary for implementing BPR. Success in the redesign effort requires many other changes including roles and responsibilities, incentives, organizational structure, and skills (Hall et al. 1993).

## Management Implications

The relationship between IT infrastructure and business process redesign holds some important implications for managing IT investments. These can be described from two viewpoints: that of the BPR champion and that of the information systems executive.

### Implications for Business Process Redesign Champions

Successful process innovation makes many demands on a firm, including its IT infrastructure capabilities. As evidenced in the four firms studied, the implementation of radically redesigned business processes will almost certainly require extensive IT infrastructure capabilities. If these capabilities are not in place when BPR is launched, added implementation cost and time delay will likely result. Specific boundary-crossing infrastructure services play a major role in enabling process innovation. Conscious investment in these infrastructure capabilities beyond current needs can smooth the path to radical business process redesign. However, if these capabilities are not quickly utilized to support BPR or other initiatives, they constitute an over-investment that is wasted. Thus, a delicate balance is necessary between potential delays to important change initiatives, such as BPR, and over-investing in IT infrastructure where the extensive capabilities are never exploited.

If a firm is engaged in process simplification, the existence of at least a medium level of IT infrastructure capability (i.e., services and reach and range) is likely to assist in implementation of the new processes. The existence of extensive infrastructure capabilities may further improve implementation speed, but the benefits are likely to be marginal.

Before embarking on any form of BPR, managers should complete a business audit of their infrastructure capabilities. The current level of a firm's infrastructure capability can be assessed by checking the evidence for each of the 23 infrastructure services and the extent of reach and range. Important questions to consider include:

- To what extent does the firm have at least the 10 core infrastructure services (see Table 1) together with the seven boundary-crossing services in place?
- What is the reach in terms of who can be seamlessly connected?
- What range of services are available: only the ability to access information or the capacity to perform complex business transactions across multiple systems?

As experienced by StockCo, failing to address the suitability of IT infrastructure when beginning BPR efforts can cause implementation to stall while the required infrastructure capabilities are being built according to an expedited schedule.

### **Implications for Information Systems Executives**

This research found that having the "right" IT infrastructure services in place speeds implementation of new process designs. If the required infrastructure services do not already exist, the business benefits of the redesigned or new business processes can be a powerful argument to justify the infrastructure investments for BPR and other initiatives. Whatever the initial state of a firm's infrastructure, successful business process redesign will likely result in some extension or renewal of IT infrastructure capabilities. This new shared infrastructure can then be used by other applications at marginal cost (e.g., a knowledge management support system), which become

financially feasible now that the IT infrastructure exists (e.g., PC/LAN and network infrastructure).

Indeed, it was observed that BPR provided the basis for the financial justification of needed IT infrastructure that was then utilized by other applications, thus illustrating the shared nature of IT infrastructure and its similarity to public infrastructure (e.g., roads).

The existence of rich infrastructure capabilities can encourage a more aggressive approach to business process redesign. However, making extensive infrastructure investments in advance of current business needs is far more difficult to sell to top management, as it requires the valuation of the flexibility that extensive infrastructure brings.

## **Conclusion**

IT infrastructure capability has an impact on the speed and nature of process change. Four infrastructure services were identified that were part of the IT capabilities in the two firms that had implemented extensive business process changes and not in the other two firms. Reach and particularly range were also higher in the two firms that implemented faster and more extensive process changes. This higher level of infrastructure capability facilitated cross-business and cross-functional applications through firm-wide consistency, architecture and standards in systems development, data, applications, and management information.

In this limited sample IT infrastructure capabilities facilitated the implementation of redesigned processes. The impact tended to be greater when extensive IT infrastructure capabilities were implemented before or alongside process innovation activities.

Management's perspective on IT infrastructure capabilities and the way in which infrastructure is justified is likely to have an impact on the extent of process change undertaken. Extensive IT infrastructure capabilities facilitated both process simplification and process innovation, but may be over-investment for the former.

Limited IT infrastructure capability can hinder process innovation.

The firms taking a process innovation approach were in turnaround situations where there was real urgency about the improvement needed in their competitive situation. Strategically focused infrastructure-building and service provision was a critical corequisite for completing process innovation in these firms.

Conversely, the stalling or slower than expected progress in implementing process redesign due to inadequate IT infrastructure capabilities can provide a powerful basis for justification of investment in infrastructure.

The dilemma faced by a firm in crisis is that implementing process innovation requires an extensive set of infrastructure capabilities. However, a firm in crisis often lacks those services and the time and resources to develop them. The question of whether the necessary infrastructure services required for process innovation can be acquired quickly via outsourcing is an important topic for future work.

This paper has explored the links between the role of IT infrastructure in firms and business process change. Of the firms studied, those which had developed a rich set of IT infrastructure capabilities, before or concurrent with undertaking business process redesign, were able to implement dramatic changes to their business processes over relatively short time frames. A rich set of infrastructure capabilities includes the boundary-crossing services and range-enabling complex transactions across multisite business units. The achievement of process innovation rested in part on appropriate firm-wide IT infrastructure capabilities being in place. Less dramatic change, by way of process simplification, was possible with more modest IT infrastructure capabilities and a more incremental approach to changes in IT infrastructure.

### Acknowledgements

We would like to gratefully acknowledge the time and insights of the senior managers who participated in this study as well as important contributions of the editor-in-chief, the senior

editor, the associate editor, the reviewers, and Carey Butler and Margi Olson who provided comments on earlier versions of this paper. Funding for this research was provided by the IBM Consulting Group.

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## APPENDIX

### Data Gathered From the Firms

#### *Strategy and Business Drivers*

Initial data came from written responses to an open-ended question in the response form about the firm's strategic intent and desired leadership position (Hamel and Prahalad 1989, 1994) asked of the chief information officer (CIO) and the corporate executive (CE). In the subsequent interview sessions, firm-wide business drivers flowing from strategic intent statements were identified, and later checked for their accuracy with both the CIO and CE. Business unit strategies were identified initially through questions on the response form asked of both the business unit information systems manager (BUIIS) and the CE. The questions drew on Porter's (1985) generic strategies and Bowman and Johnson's (1992) elaboration of these for more detailed descriptions of competitive strategies. These too were followed up in subsequent interview sessions and later checked for their accuracy.

#### *BPR Motivation, Process Changes, and Impact*

The motivation, nature, and impact of BPR were assessed, initially, in interview sessions with the CIO, CE and BUIIS managers. In three of the firms, additional interview sessions were held with other business managers who were key participants in the BPR, such as executive sponsors of the BPR and members of BPR project teams. In addition, in three of the firms, executive managers had given industry presentations about their process changes and their notes and papers were made available to the researchers. The annual report of the fourth firm outlined the motivation and nature of the changes being undertaken. In all firms, access was given to significant documents that announced the commencement of the process changes and internal memos that reported progress and outcomes.

#### *Infrastructure Investments*

The CIO provided details of the firm's total IT investment over the past five years, together with the proportion that was firm-wide IT infrastructure. IT investment included dollars invested in all computers, hardware, software, communications, phone, fax, data, and the people dedicated to providing IT services. Firm-wide IT infrastructure is defined as the component of the IT investment provided centrally as services and shared throughout the multibusiness unit firms. At subsequent interview sessions, the researchers worked extensively with the CIO to identify the firm's infrastructure costs and their components in a way that was consistent across all firms.

#### *Decision Making for IT Infrastructure Investments*

The CIO answered 12 questions (with Likert scales) on how the firm justified investment in IT infrastructure. The questions identified the extent of specific management objectives used for justifications, for example, cost savings, flexibility. Three sets of four questions assessed the tendency of the firm to take different approaches to infrastructure investments.

## **IT Infrastructure Capabilities**

### **Infrastructure Services**

During the interviews, the extent of firm-wide infrastructure services provided were identified. These were tabulated against a list of services identified in 27 large firms and grouped into services that existed in all firms and those that existed in at least one of the firms, but not all of the firms (see Table 1).

### **Reach and Range of IT Infrastructure**

A series of questions for the CIO resulted in a plot of reach and range (Keen 1991; Keen and Cummins 1994).

**Note:** All firms checked for accuracy the five to six page summaries of their strategic orientation, process changes, infrastructure investments, view of infrastructure, and the extent of their IT infrastructure capabilities.