

A Comparative Study of the Application of Electronic Data Interchange and Internet Technology to Business Process Reengineering

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Abstract: This study investigates the role of information technology in business process reengineering (BPR) implementation. To increase the prospects of successful BPR implementation, the role of information technology in BPR should be thoroughly investigated to find the logical relationships between information technology and BPR. This study used a survey methodology to gather information from 72 BPR programs. The results show that different information technologies, such as those examined in this study, electronic data interchange (EDI) and Internet, provide different capabilities and can be useful in different ways and for different purposes. Lack of attention to these relationships may be due to the unacceptable high implementation failure rate in the previous BPR efforts.

Key words: business process reengineering; organizational enablers; information technology

Introduction

The concept of business process reengineering (BPR) was first introduced by Hammer in 1990^[1]. It has become a popular management tool for dealing with rapid technological and business change in today's competitive environment. BPR evolved from the experiences of a few American companies in the late 1980s^[2]. They radically changed their work process by applying modern information technology. Report of their dramatically-improved performance helped to make the American management phenomenon of reengineering in the early 1990s and its international diffusion.

Organizations have different departments, such as sales, marketing, finance, purchasing, and production, and each department is responsible for undertaking one part of a large whole. This chain of linked departments allows for specialization where the overall task is broken down and people with specific expertise can be

applied as required. Such specialization of labor, whether on the manufacturing shop floor or within offices has been a normal way of working for a long time. Levels of seniority evolve within these functions to form the organizational hierarchy. This model is so widely established that it is rarely questioned. All are changing now. BPR is questioning this functional way of thinking and is focusing on process organizations.

Figure 1 illustrates the shift from functional organization to process organization. Figure 1a shows that the organization is actually made up of a number of sub-organizations known as functions, each of which has its own management hierarchy. Figure 1b shows that management focus has traditionally been on the functional hierarchy. Figure 1c shows that BPR emphasizes a "process" view, which cuts across the functional hierarchies to reach the customer.

Organizations adopting a process approach find that many steps in their order cycle have nothing to do with delivering the required outcomes. It is sometimes difficult to identify why some steps exist at all. It is for no other reason than that they always have been! Getting

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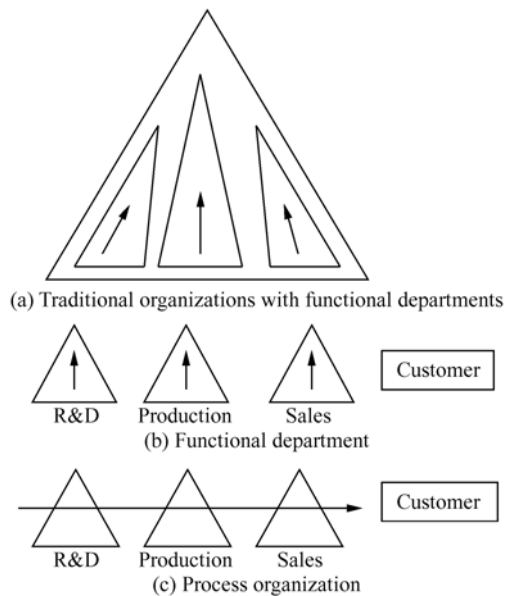


Fig. 1 Shift from functional organization to process organization

rid of all these unnecessary steps means quicker customer services at considerably lower cost, which is all possible by conducting BPR.

BPR has been defined and conceptualized in many different ways. The following sample of BPR definitions illustrates the slightly varying views of many researchers and practitioners.

“Total transformation of a business: an unconstrained reshaping of all business processes, technologies and management systems, as well as organizational structure and values, to achieve quantum leaps in performance throughout the business.”^[3]

“Use the power of modern information technology to radically redesign business processes in order to achieve dramatic improvements in performance.”^[11]

“The process of fundamentally changing the way work is performed in order to achieve radical performance improvements in speed, cost, and quality.”^[4]

From the practitioner definitions, there are five elements that stand out to form the critical issues that define BPR: 1) BPR consists of radical or at least significant changes; 2) BPR’s unit of analysis is the business process, not the departments or functional areas; 3) BPR tries to achieve major goals or dramatic performance improvements; 4) information technology (IT) is a critical enabler of BPR; and 5) organizational changes are a critical enabler of BPR and must be managed accordingly.

BPR is an important topic in management circles.

Some recent works have found a growing awareness to BPR in Asian countries and regions, such as Singapore, Hong Kong of China and Mainland China^[5,21]. Numerous organizations have reported that they successfully implement their BPR by containing costs and achieve breakthrough performance in a variety of parameters, such as delivery times, customer service, and quality. For example, Bell Atlantic reduced the time to install new telecommunication circuits from 15 days to 3 days, and cut labor cost from US\$ 88 million to US\$ 6 million^[6]. Ford Motor reduced its account payable staff by 75% with BPR. Motorola, when faced with higher defects and longer cycles, redesigned its parts and tooling process, simultaneously upgrading its manufacturing equipment, which decreased the total production cost by US\$ 1 billion per year, and cut cycle time by half^[7]. Other often cited examples of successful BPR programs include AT&T, Eastman Kodak, Hallmark Cards Inc. and IBM Credit^[8,9].

However, not all companies that undertake BPR achieve their intended results. Hammer and Champy^[10] reveals that as many as 50% to 70% of organizations that make an effort to employ BPR do not achieve the dramatic results they seek. These mixed results make issues of BPR implementation especially important. BPR has great potential for increasing productivity through reduced process time and cost, improved quality and greater customer satisfaction, but to do so, it must be implemented and be managed in the best interest of customers, employees, and organizations.

1 BPR and IT Enablers

IT plays an enabling role in BPR. An enabler is an agent that allows organizations to break their old rules and create new reengineered processes^[10].

IT should be considered as more than an automating or augmenting force. It can fundamentally reshape or enable the way that business processes are done. IT can include any enabling technology that an organization uses to support its business. This includes its systems for manufacturing, information management, control, measurement, design, and engineering. IT obviously has great potential, but it is difficult to use effectively. BPR addresses these difficulties by directly designing the effective use of IT into reengineered business processes. Although IT is not the solution, the use of IT to improve processes is essential in BPR.

During BPR's examination of existing business processes, new and improved uses of IT are often discovered. It is BPR that can relate the use of IT directly to business processes.

In addition to the productivity improvement, IT can also enable radical alterations of the cost structure of jobs. However, to actually change jobs takes a combination of management leadership and employee participation. IT is also an enabler of social and organizational transformation, making it an integral part of an organization's strategy^[11].

Previously, IT had been used primarily in manufacturing for process modeling, production scheduling, materials management, and logistics. The manufacturing function was the most likely and obvious candidate for BPR. Literature is replete with examples of how BPR helped manufacturing firms to contain cost and achieve breakthrough performance^[7-10]. However, IT is now enabling the integration of business functions at all levels within and between organizations. The ability to electronically connect people and tasks continues to become increasingly affordable and available. Boundaries of organizations are being torn down. IT can enable changes in where work gets done, when, and with whom.

Some categories of information technologies that are commonly used in BPR programs are listed below:

- Databases and related technologies;
- Networking and communication;
- Electronic data interchange (EDI);
- Workflow automation and group ware;
- Internet web-based technology;
- Enterprise system and enterprise resource planning (ERP);
- Multimedia and interactive computing.

Of course, this list is neither exhaustive nor mutually exclusive. However, a firm needs to make independent decisions about each^[5].

IT enables BPR by providing tools necessary to analyze, communicate, and redesign business processes. IT in this study refers specifically to electronic data interchange and Internet technology.

1.1 EDI as an IT enabler

The idea of doing business in the networks developed in the 1960s when electronic data interchange and electronic fund transfer (EFT) were first introduced to

banks and financial institutes and gradually expanded to many other applications for exchanging data among private networks^[5].

The United Nations EDI for Administration, Commerce, and Transportation (UN/EDIFACT) defines EDI as standard formatted data interchange between computer application systems of trading partners with minimal manual intervention^[13].

EDI is a rapidly growing technology. The number of registered EDI users, according to EDI yellow pages international, has shown impressive gains in the past several years, well in excess of a 50% annual growth rate^[14].

Of course, routine communications over the Internet are widely accepted, and even EDI over the Internet is increasing because of its lower costs. However, the issues of security, accuracy, and the size of files may hold up Internet usage for production and business transactions^[15].

EDI enables BPR through faster processing speed to increase the accuracy and the competitive advantages, reduce costs, and to improve operation, security, tracking and control, intra and inter company communications, and customer service^[14].

1.2 Internet as an IT enabler

One of the most recent ITs used in BPR is Internet technology^[11]. Internet is the most widely used and fastest growing technology compared to other available technologies. According to estimating the number of Internet users surpassed 550 million or about 10% of the world's population by the year 2000^[16]. Since initiation, it took only five years to reach 10 million users with an average of 2 million new users each year.

Figure 2 illustrates the diffusion of web-based Internet technology compared to other technologies.

Internet technology enables BPR projects to have three benefits: 1) decreased cost; 2) easy availability; and 3) high compatibility. The cost benefit of Internet technology includes the cost of Internet technology itself as well as cost savings incurred through its use. Internet technology has saved costs by allowing faster and easier access to more accurate company information. It is excellent for reducing printing costs and distribution time. For example, analysts estimate that 18% of corporate printed material becomes outdated within 30 days^[17]. Documents that are printed and mailed,

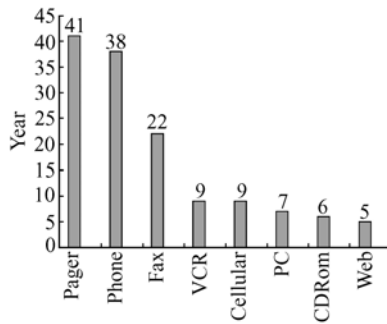


Fig. 2 Number of years for different technologies to reach 10 million consumers

such as phone books, policy and training manuals, requisition forms, and marketing materials, can be put on a dedicated Internet server and updated for a fraction of the cost of reprinting the material. Benefits from increased productivity are more difficult to measure than savings from the reduced cost of printing and distributing manuals. For example, organizations are using the Internet to efficiently connect their field sales representative to their home office and to each other. They can easily obtain product information, or collaborate on pursuing sales leads^[17].

Internet technology enables BPR through the availability of the technology itself as well as through making information more easily and quickly available. Productivity increases as Internet technology enables more rapid and easier exchange of information. It allows information delivery to be flexible.

Internet technology allows both structured and unstructured information to be easily accessed from data storage throughout an organization. Cross-functional teams can proactively share information about issues such as: 1) employee policies; 2) daily announcements; 3) company mission and objectives; and 4) project information.

For example, Ford Motor Company used Internet technology to facilitate the global exchange of information to create 24-hours-a-day, 7-days-a-week organizational productivity. Design centers in Asia, Europe, and the United States were connected through Internet technology to engineer in the 1996 Ford Taurus^[17].

Different information technologies provide different capabilities and can be useful in different ways. For example, the main characteristics of EDI and Internet technology are summarized in Table 1. Of course, similar differences exist among other information technologies that are commonly used in BPR. How-

ever, we only focus on EDI and Internet technology because we believe that the differences between these two technologies are more tangible.

Table 1 Main characteristics of EDI and Internet technology

Characteristic	EDI	Internet
Electronic commerce	Adaptable	Adaptable
Data structure	Highly structured	Both structured and unstructured
Processing speed	High	Medium
Accuracy	High	Medium
Tracking and control	High	Medium
Security	High	Low
Investment requirement	High	Low
Any time any where application	Low	High
Ease of use	Low	High
User friendly	Low	High

2 Methodology and Sample

Based on the nature and purpose of this research, a survey approach was chosen, using informants and respondents to gather information. The questionnaire was prepared using information gleaned from prior literature in the area. It was first tested with expertise in information systems and BPR, and based on their feedback, appropriate changes were made to the questionnaire. We chose two methods to solicit responses: web-based and paper-based.

1) In November 2001, our finalized questionnaires were transmitted via e-mail to 190 selected companies for two specific industries: automotive parts and electronics.

2) In January 2002, finalized questionnaires were distributed to 155 selected companies who attended the first International Conference on Intellectual Property and E-business. This event was used to examine the benefits offered by the convergence of major industries engaged in information technology.

A total of 345 questionnaires were distributed, 77 were returned, for a response rate of 22%. Five of the returned questionnaires were deemed invalid because too many values were missing or incomplete. Thus 72 companies are examined in this study. The demographic of respondent organizations are shown in Figs. 3-6.

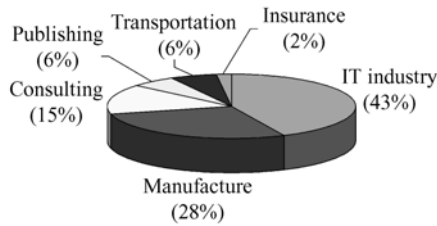


Fig. 3 Participating organizations

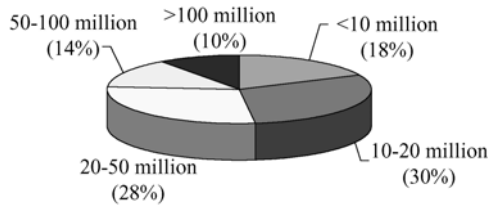


Fig. 4 Sample demographics revenue (US\$)

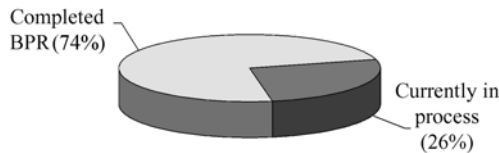


Fig. 5 BPR implementation statistics

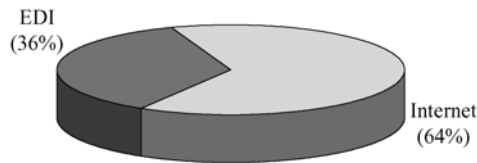


Fig. 6 Type of IT used in BPR projects

3 Results and Discussion

The data revealed that 74% (53 companies) of our respondent companies had completed some BPR projects in the past 18 months and 26% (19 companies) had some BPR projects currently under implementation.

All of the BPR projects in this research used either EDI or Internet technology. Any questionnaires returned that did not use EDI or Internet technology were not included in the analysis. As depicted in Fig. 6, 64% of our respondent companies cited the Internet as an IT enabler for their BPR efforts.

We tried to assess the functional areas that have been targeted for BPR efforts by participant organizations. The statistics are presented in Table 2. From Table 2, it is evident that participant organizations have essentially focused on their customer services followed by order management, inventory management, and purchasing management for either EDI or

Internet application. Our results are different from the results of the CSC/Index survey which reported that accounting and finance were the functions that were reengineered by the most North American companies, followed by marketing and sales. We also find that the frequency of selected information technology is different within the selected process for reengineering. For example, human resource management, new product development, and marketing management rank 5, 6, and 7 for Internet application and rank 10, 13, and 12 for EDI application to BPR, respectively.

Table 2 Comparison of selected process for reengineering by using EDI or Internet technology

Type of business	Rank in Internet	Rank in EDI
Customer service	1	1
Order management	2	2
Inventory management	3	3
Purchasing	4	4
Human resources	5	7
New product development	6	10
Marketing	7	13
Research and development	8	12
Sales	9	15
Production	10	14
Receiving	11	16
Shipping	12	17
Billing	13	6
Invoicing	14	5
Accounts receivable	15	8

Table 3 Comparison of reasons for using EDI or Internet technology for BPR

Reasons for using Internet or EDI	Rank in Internet	Rank in EDI
Easier access to information	1	15
Electronic commerce	2	6
Cost reduction	3	7
Reduce geographic distance	4	17
Faster processing speed	5	8
Reduce geographic distance	6	4
Reduce distribution costs	7	12
Easily accessible communication network	8	14
Faster access to information	9	13
Reduce paper flow	10	11
Access to more accurate information	11	9
Communication between employees	12	16
Global exchange of information	13	18
Increase productivity	14	3
Efficient connection of organizational resources	15	1
Exchange information	16	2

BPR programs may be undertaken for a variety of reasons. Our survey indicates significant differences among the objectives for BPR, when two different information technologies, EDI or Internet, were applied to BPR. Easier access to information, electronic commerce, and cost reduction are the main motives for undertaking BPR by applying Internet technology. Efficient connection of organizational resources, exchange information, and increased productivity seem to be the most important reasons for applying EDI to BPR. The results of our survey support the CSC/Index survey of North American companies in which cost cutting was ranked as the second most important objective, next to improving the speed of business processes.

Another survey of 80 American corporations identified cost cutting as a major goal for BPR programs^[18]. A study of European organizations also found that BPR projects in Europe are mostly concerned with saving of cost and time^[19]. As indicated in Table 3, there is a different relationship between selected information technology, EDI or Internet, with the objectives of BPR.

For example, for objectives such as easier access to information, electronic commerce, and cost reduction, it seems that Internet technology is more highly preferred for reengineering than EDI, ranked 1, 2, and 3, compared to 15, 6, and 7. For objectives such as efficient connection of organizational resources, exchange information, and increased productivity, EDI ranks 1,2, and 3, and internet application ranks 15, 16, and 14, respectively.

4 Statistical Analysis

The reliability of collected data was examined using Cronbach's coefficient alpha. The Cronbach's alpha value is 0.7417, which is relatively high, and falls within the acceptable range. Although there is no definite criteria for testing the reliability coefficient, a low value of alpha (close to 0) indicates that the sample of items is a poor representation of variables, while a high value of alpha (close to 1) indicates that the items are internally related in the manner expected. In this study, the reliability tests produced relatively higher alpha value that is acceptable.

We tried to assess BPR from different perspectives. A series of variance analyses were performed to further investigate the responses by the participant organization to the selected variables.

organization to the selected variables.

4.1 Perceived success of BPR across different kinds of organizations

We performed ANOVA to investigate the perceived success scores across three main participant organizations, including IT related business, manufacturing, and consulting firms. It was found that the mean scores were significantly different across different organization types ($F = 13.2, P < 0.05$).

While the mean for perceived success score was lowest among the consulting firms, it was highest among the IT industries. This is not surprising. IT industries are more familiar with capabilities of different IT and can better utilize appropriate IT for their BPR efforts. See Table 4 for more statistics.

Table 4 ANOVA: Perceived success of BPR across different organizations^a

Participant organizations	Mean	S.D.	<i>F</i>
IT industries	3.65	0.29	13.2
Manufacturing	3.34	0.19	
Consulting	3.32	0.26	

^a 1, low; 5, high

4.2 Perceived success of BPR between EDI and Internet application

We performed ANOVA to see if there are any significant differences among the perceived success scores across selected technologies for BPR. It was found that the mean scores were significantly different between EDI and Internet application with mean score of 3.25 for EDI and 3.55 for Internet ($F = 8.97, P < 0.05$). The results are shown in Table 5.

Table 5 ANOVA: Perceived success of BPR across different information technology^a

Selected technology	Mean	S.D.	<i>F</i>
EDI	3.25	0.45	8.97
Internet	3.55	0.37	

^a 1, low; 5, high

4.3 Problems in BPR

Through review of the literature^[20-23], we compiled a list of four main problems commonly encountered in BPR efforts and included in the questionnaire. The severity of the problems was again measured on a Likert scale of 1 to 5. Financial problems, technical ability,

human resources, and time limitation are the greatest problems when firms engage in BPR. To determine whether there were any significant differences in the severity of problems in BPR efforts among three main participant organizations, the ANOVA test was per-

formed. Two of the four problems involving human resources and technical ability were significantly different among different organizations. The results are presented in Table 6.

Table 6 ANOVA: Problems in BPR across different kind of organizations^a

Problems in BPR	Mean			S.D.			F
	IT industries	Manufacturing	Consulting firms	IT industries	Manufacturing	Consulting firms	
Financial problems	3.54	3.52	3.36	0.29	0.32	0.32	1.45
Technical abilities	3.32	3.70	3.46	0.20	0.28	0.33	12.80
Human resources	3.34	3.69	3.70	0.21	0.23	0.33	15.81
Time schedule	3.54	3.48	3.40	0.29	0.33	0.32	0.85

^a 1, low; 5, high

5 Conclusions

This study found significant differences between selected information technology for BPR. Perceived success score for participant organizations that applied Internet technology for BPR is significantly higher than those which applied EDI. This higher success result is perhaps due to friendly characteristics and the ease of the use of Internet technology. By comparison of selected technologies, we found that different BPR programs may demand different information technology. Lack of attention to this relationship may be one reason for unacceptably high implementation failure rate in the previous BPR efforts.

We also found that perceived success score was the highest among the IT industries. This means that organizations with better understanding of information technology can better handle their BPR programs by utilizing appropriate IT for their BPR efforts.

We also find that financial problems, technical ability, human resources, and time limitation are the greatest problems when firms engage in BPR. Understanding the expected problems and severity of them can help organizations to face these problems properly and increase the possibility of a successful implementation of BPR.

The findings of this research can help practitioners to better understand the role of information technology in BPR. By determining the factors that affect BPR implementation, we can manage these factors in the best interest of organizations, customers, and employees.

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