A FRAMEWORK FOR REALIZING THE POTENTIAL OF INFORMATION TECHNOLOGY IN DEVELOPING COUNTRIES

Abbas N. Azad
Alton S. Erdem
Naveed Saleem

Information technology can play a strategic role at micro as well as at macro - organizational and national-levels. Developed countries have extensively benefitted from this technology at both levels. Can developing countries duplicate this experience with the technology and thereby foster healthy economic environment within their boundaries and strengthen their abilities to compete in the global markets? This paper addresses this issue. The paper evaluates the prevalent applications of information technology in developing countries, deliberates the potential of the technology, and presents a framework for realizing this potential. The framework proposes strategies to assure smooth and accelerated diffusion of technology in organizations. Importantly, the framework points out the factors, unique to developing countries, that must be addressed in technology planning and implementation. Ignoring these factors may result in failed systems and continued technological disadvantage.

INTRODUCTION

Information technology (IT) offers strategic potential at micro as well as macro-organizational and national-levels. At the organizational level, this technology is rapidly changing the business environment, practices and relationships. For instance, competition has become global - customers and suppliers are no longer restricted by national boundaries but span the world. Just-in-time inventory management has become a strategic tool for efficient

employment of resources. Locking in customers and suppliers has become a viable strategy to gain a competitive advantage. Only information technology makes all this possible.

At the macro level, IT revolution holds critical implications for the economic growth and international trade of developed as well as developing countries (Cole, 1982; Alfthan, 1985). IT has altered the competitive environment among different countries by globalizing the markets and by changing the absolute and comparative economic advantages of individual countries (Grieco, 1982). Consequently, this technology posits critical challenges and opportunities for developing countries in particular (Cornoy, 1985).

Economies of developing countries are traditionally based on primary goods like agricultural products, raw materials, and handicrafts. The need to accelerate industrial development and improve competitiveness, however, has precipitated the drive towards non-traditional manufactured products (Rammamurthi, 1985). Experts acknowledge the important role IT can play in this process (Rammamurthi, 1985; Saraswat & Gorgone, 1991). However, given a surplus of manpower in most of these countries, the perception that the computer is a labor-substituting technology alarms governments and labor unions. Saraswat and Gorgone (1991), nonetheless, maintain that this skepticism is changing because IT can create tremendous employment opportunities in the areas of data entry and analysis, software development, processing of microchips, and assembly of circuit boards. Clearly, the recognition of the IT potential is on the rise.

The existing research, nevertheless, offers few guidelines for planning, implementing, and expanding the role of the technology in developing countries. Lack of such guidelines can result in haphazard efforts and trial-and-error approaches to integrate the technology in private and public sectors. This can result in inefficient and ineffective uses of technology and thereby jeopardize the efforts to overcome the technological disadvantage in competing in international markets. This paper examines the prevalent IT applications in developing countries, deliberates the potential of this technology, and presents a framework for realizing this potential.

INFORMATION TECHNOLOGY APPLICATION CATEGORIES

To facilitate understanding the nature of IT applications in developing countries, this section describes the general categories of information technology applications. These categories include the following (O'Brien, 1995):

1. Transaction Processing Systems (TPS)

These systems record and process data resulting from business transactions such as sales, purchases, payments and receipts. The systems then produce information products such as customer statements, sales receipts, purchase orders, financial statements and a variety of other information for internal and external use.

2. Information Reporting Systems (IRS)

Information reporting systems support monitoring and control functions of management by accessing databases containing information about internal operations and organizational performance. This kind of system, for instance, will aid weekly sales analysis by product, sales person, and sales territory.

3. Decision Support Systems (DSS)

These systems include mathematical models (such as statistical, financial or accounting models), internal data generated from business transactions and operations, and external data. A DSS helps a manager understand problems/ opportunities faced by the organization, design possible alternative actions, and select the best alternative. For instance, a manager may use the DSS to understand the factors causing a decline in sales and design strategies to reverse the trend.

4. Office Automation Systems (OAS)

An office automation system collects, processes, stores, and transmits data and information in the form of electronic office communications. Examples include word processing, electronic mail, desktop publishing, teleconferencing, and document image processing.

5. Process Control Systems (PCS)

A process control systems automatically adjusts the physical production process. Petroleum refineries and assembly lines of automated factories make use of such systems.

6. Telecommunications Systems (TS)

These systems facilitate the transmitting and receiving of data over communication links between one or more computer systems and a variety of input/output devices within the organization and among different organizations. Telecommunication applications include electronic fund transfers, point-of-sale systems, data interchange, and cooperative processing.

7. Expert Systems (ES)

An Expert System is a knowledge-based system that uses its knowledge about a specific domain to act as a consultant to a system user. ES applications include diagnosis of illnesses, search for minerals, analysis of compounds, and financial planning. These systems can support both operations and management activities in an organization.

A SURVEY OF IT APPLICATIONS IN DEVELOPING COUNTRIES

This section surveys information technology applications in developing countries as reported in the literature. The purpose of this survey is to characterize these applications in terms of information systems categories presented in the previous section.

Developing countries employ information technology in public as well as in private sectors (Rammamurthi, 1985). For example, Egypt's Decision Support Center (IDSC) has developed a "Debt Management Project," which is credited with playing a key role in producing a model that resulted in the negotiation of very favorable terms for foreign creditors in debt rescheduling (Goodman & Green, 1992). Also, experts at the Regional Information Technology and Software Engineering Center are developing a "cultural multimedia" system that will capture valuable ancient manuscripts in computerized form. This system is primarily an information storage and retrieval system.

Jordan has been using an information reporting system called "The Geographical Information System" (GIS) to record over 20,000 geographical antiquity sites. This system helps archaeologists plan their excavations and surveys more effectively (Goodman & Green, 1992). The hardware for this project covers the full range of computer systems from mainframes to PCs.

Joshi (1990) describes systems in use in a large engineering company in India. These systems support payroll, accounting, and materials requirements planning functions. Information systems are also employed in planning public services in this country (Goodman & Green, 1992). The IT applications in private and public sectors primarily include transactions processing, information reporting, and decision support systems.

Tunisia's efforts are illustrative of activities in several countries (Goodman & Green, 1992). The Tunisian government has made IT a "privileged" sector. To encourage use of the technology, the government recently cut tariffs on computer imports from 50% to 10%. Computers are heavily used to support government functions, banking, and public utilities. The system categories utilized include transaction processing systems, information reporting systems, and decision support systems.

Malaysia developed a system called SETIA, a decision support system, that assists government agencies in planning, registering and controlling development projects; preparing budget allocations; and reporting physical and financial progress of projects (Han & Render, 1989).

To summarize, developing countries have made slow but steady progress in integrating information technology in public and private sectors. However, most of the applications automate routine tasks and support management control. Decision support systems primarily exist in public sectors. Advanced applications such as process control, telecommunications, and expert systems are a rarity.

POTENTIAL OF IT APPLICATIONS

Realizing the potential of information technology demands that organizations - public and private - must not only automate, but must anticipate entirely new functions while simultaneously improving current

practices. This section points out organizational functions and tasks that may particularly benefit from this technology.

An obvious and critical area of application is the improvement of administrative and operational efficiency in the public and private sectors (Saraswat, 1985). For instance, in preparing plans for medical, educational, or other services to a community, the inefficient manual methods of maintaining and providing necessary and relevant data may result in delayed or inadequate plans. Moreover, this inefficiency may prohibit timely intervention to monitor and improve the service. Information technology is extremely effective in minimizing such inefficiencies.

Information systems may also help minimize certain forms of bureaucratic corruption and thereby enhance the quality of services provided. Saraswat (1985) notes that most of the corruption in the developing world is procedure-oriented. Often these procedures reflect unmanageable bureaucracies and are oriented toward maintaining control rather than service. This orientation generates abuse of bureaucratic power and corruption. In industrialized countries, information systems are credited for reducing levels of management in organizations and for streamlining organizational procedures (O'Brien, 1995). Consequently, employing information technology to automate information gathering and analysis, and streamlining procedures can help minimize bureaucratic corruption.

Organizational functions, such as quality control and sales, that have a direct bearing on organizational performance are prime candidates for computerized support. Information systems can be effective in collecting and analyzing relevant data, in order to enhance and maintain the quality of a product or service. This can help an organization's competitive position in national and global markets. Likewise, using information systems to integrate sales, production scheduling, and material requirements data can help streamline operations, minimize costs, and generate customer satisfaction and goodwill.

Industries, such as banking, finance, and healthcare that have linkages with organizations abroad, can particularly benefit from information systems. High levels of literacy among personnel in such industries will help absorption and diffusion of technology.

FRAMEWORK FOR SYSTEMS PLANNING AND IMPLEMENTATION

This section presents a framework for coordinating the efforts to introduce or expand IT applications in organizations. Such an effort, the framework points out, is an evolving process with technical, organizational, and environmental dimensions to it. Each dimension points out issues that must be evaluated and addressed by the organization.

The Technical Dimension

The technical dimension provides guidance in planning future applications of information technology based on the present experience with technology. This dimension is based on The Stage Model which is described next.

The Stage Model

Nolan and Gibson (1974) examined the evolution of information systems function in a large number of organizations and developed a conceptual model, named **The Stage Model**, for understanding the introduction and assimilation of IT in organizations. Nolan (1979) further refined this model and theorized that organizations go through the following six predictable stages of growth as they adopt and implement information technology.

Stage 1: Initiation

In this stage, the technology is initially introduced into the organization and some users begin to find applications. The use grows slowly as people become familiar with the technology and its applications. The initial application typically target cost reduction functions. An organization at this stage must find applications that are visible and have greatest likelihood of success. This will instill greater organizational confidence in the merits and relevance of the technology.

Stage 2: Contagion

As more individuals and departments become acquainted with it, demand increases and use of the technology proliferates. Enthusiasm for the new technology builds rapidly during this stage. There is little additional planning done at this stage. However, the organization must encourage experimenting with the use of technology.

Stage 3: Control

During this stage, the issue of costs and benefits intensifies and management becomes increasingly concerned about the economies of the technology. An organization, at this stage, must select applications that offer the greatest promise for the organization and that can be justified on the basis of cost/benefit analysis.

Stage 4: Integration

As systems proliferate within the organization and databases continue to grow, the notion of system integration becomes dominant. Management become interested in leveraging integrated systems and their databases. The goal at this stage is to integrate the systems to facilitate information sharing to streamline operations.

Stage 5: Data Administration

During the data-administration stage, management is concerned with the valuable data resources. Functions are created to manage and control the databases and to ensure that they are utilized effectively. The objective at this stage is to implement mechanisms for achieving integration among applications.

Stage 6: Maturity

In this stage, if it ever occurs, the technology and the management processes are integrated into an efficiently functioning entity.

The Stage Model is an important management concept because it provides insight into the technology adoption process and predictability. Drawing on this model, managers can make reasonable assertions concerning the future behavior of their organizations and prepare themselves and their organizations according to their observations of the present. Organizations with limited technology experience must target structured applications and minimize control on the use of technology. Technically experienced firms may even overlap two or more stages and may target complex applications in an integrated environment. Thus, the model provides guidance in planning future activities.

Organizational Considerations

Traditionally, developing and implementing an information system was primarily treated as a technical undertaking. However, this view changed because a significant research suggested that organizational problems, rather than technical system problems, were the primary reason for the system failures in organizations (Lucas, 1975; Edstrom, 1977; Newman & Noble, 1990). The current view is that technology is merely one of the components of an information system.

Planned organizational change approach (Lewin, 1952) may be employed to develop a receptive organizational environment for system introduction. The "change" in this concept refers to a planned, deliberate change in organizations; rather than an inevitable, sudden change. According to this concept, every change contains forces that are for it or against it. More importantly, increasing forces which support a change without decreasing forces that oppose the change creates tensions and conflicts due to a possible increase in the opposing forces. Moreover, increasing support forces beyond a certain level may result in a higher level of conflict and tension. Accordingly, a preferred strategy to implement a change calls for a decrease in the forces opposed to the change by establishing an accepted need for change, identifying and reducing the forces which are likely to resist the change, and incorporating user input in the implementation process (Lewin, 1952; Gibson, 1980; Huse 1980).

The primary focus of organizational considerations is to ensure that the personnel will accept the system being considered upon its implementation. This object will more likely be achieved if a system is implemented as a planned organizational change.

Environmental Considerations

Systems planning and implementation has environmental facets to it. This section surveys environmental factors, particularly relevant to developing countries that must be considered in this process. These factors primarily include cultural and political issues.

Cultural norms may precipitate user resistance toward a system (Goodman & Green, 1992). For instance, in many cultures information is still equated with power which restricts personnel willingness to share data

and information through integrated databases and systems. Furthermore, the concept of authority is based more on the right to command, rather than leadership through participation and example. Consequently, traditional view of authority may further intensify this unwillingness to share information with subordinates as such moves may be deemed the violation of authority. Therefore, before designing open or integrated systems, personnel in positions of authority must be convinced of the needs and objective of the system and must be assured the system is not intended to undermine the organizational hierarchy.

Another cultural factor that may induce resistance toward IT is preference for personal, rather than impersonal, contact. This may create a distaste for telecommunication applications such as electronic data interchange, electronic mail, and teleconferencing as they may appear impersonal. Implementing such applications, therefore, will require establishing a need for the system, otherwise the system may be under-utilized or may even be sabotaged.

Political factors may also seriously thwart efforts to realize benefits of information technology. For instance, governmental controls aimed at controlling transfer/dissemination of communications may undermine viability of telecommunication applications. Furthermore, in case of organizations dependent upon imported hardware/software, economic embargoes may simply render the needed technology unavailable. Consequently, these factors must be carefully weighed before launching the planning of implementation process.

Lack of public support for information technology may also hinder governmental efforts to diffuse information technology in the country. Consequently, within the public sector and the government departments that deal with the public, initial information technology applications must be targeted to benefit the public. It will help develop public interest and support for the technology, and prepare a receptive environment for implementing and diffusing technology. Otherwise, allegations of confused priorities and wastage may undermine the achievement of the expected benefits.

CONCLUSION

Industrialized countries have extensively benefitted from information technology at organizational as well as national levels. This technology holds the same potential for the developing countries as well, and these countries are growing in their awareness of this possibility.

The developing countries can take advantage of the experience gained by developed countries in implementing the technology and hence shorten the lag time for realizing the technology potential. This experience, however, suggests that tapping the technology potential entails more than simply acquiring and implementing the necessary hardware and software. It requires examining and addressing factors that pertain to technical, organizational, and environmental dimensions of the technology. Technical considerations provide guidelines in selecting candidate applications based on an assessment of the organization's experience with the technology. Organizational dimension outlines the process for developing a positive environment for the technology. Environment dimension highlights the factors, unique to developing countries, that must be addressed in planning the information technology applications. Ignoring these guidelines may result in failed systems and continued technological disadvantage.

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Abbas N. Azad is Associate Professor of Management at Slippery Rock University in Slippery Rock, Pennsylvania.

Alton S. Erdem is Assistant Professor of Marketing at the University of Houston-Clear Lake at Houston, Texas.

Naveed Saleem is Associate Professor of Information Systems at the University of Houston-Clear Lake at Houston, Texas.