

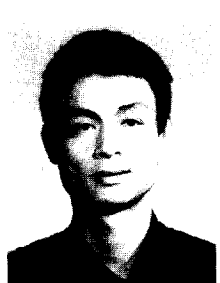
# Impact of information technology on organizations

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A literature survey on the topic of the impact of information technology on organizations revealed the interplay between the use of information technology and organizational design. In this paper an evolutionary constructionist view of the impact of information technology on organizations is presented. With this view, the information technology enabled organizational migration has three stages: knowledge link, transaction link, and business alliance link.

Keywords: Information technology, organizational design, organizational structures, business process reengineering



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## 1. Introduction

Over the past few years a tremendous number of papers have been written about organizations in the advanced information technology age. Information technology (IT) tends not to be perceived as just another example of new technology. Instead, the information dimension of IT gives it a distinctive character in contrast to other technologies. Specifically, IT enables business process reengineering (BPR) in modern organizations, and this in turn makes radical changes to old organizational structures [36]. However, the theory of how IT influences organizational forms remains underdeveloped.

Organizational theory has identified several perspectives of organizational form which best reflect organizational characteristics in various dimensions including control (e.g., work relationships, decision making levels, and compensations), culture (e.g., knowledge sharing and trust), and strategies (e.g., customer driven and strategic alliance). These are: hierarchical, network, work teams, horizontal, and matrix (see, e.g., [14]). In fact, many organizations have migrated from the traditional hierarchical form to forms that incorporate a mixture of these. From the point of view of business ecosystems, a business enterprise can move through its business environment as an integrated, flexible and adaptive organism, capable of self-restructuring, self-reshaping, and responding to a large variety of environmental perturbations [35]. This research looks at what would be a feasible path for the migration of organizations in the IT era and the role of information technology in the migration trend. The paper is based on a literature analysis and the practical observations of surrounding organizations.

## 2. Nolan and Croson's model and a critique

Nolan and Croson's book [24] offers a six stage prescription for organizational transformation toward IT enabled network. The prescription is: downsize,

balance the interests of the stakeholders, develop a market access strategy, become customer driven, develop a market foreclosure strategy, and pursue global scope. The transformation from industrial to information economy management principles requires a process of creative destruction. While the book's greatest strength is the ability to overlay IT applications on the total organizational change process, there is no lack of criticism for this model. For instance, the focus of the model is the advocacy of a 50% downsizing of organizations, but little discussion is offered on the risks and costs of such an effort [19]. Based only upon idealist assumptions about politics and human behaviour in organizations [20], the IT enabled network model suggests that the traditional hierarchical structure be completely dismantled, including pay and promotion systems in hierarchies. The authors note that the transformation toward the ideal network structure may take up to 50 years, but they fail to clarify what type of organizational structure will supplant the IT enabled network [10].

### 3. Certain effects of information technology

Because electronic group mail is usually used throughout an organization for a variety of activities, there are quite a few discussions in the literature on the effects of electronic communication on organizations. Electronic groups behave like real social groups. They share no physical space, their members are invisible, and their interaction is asynchronous [7].

New IT has altered the information environment of many organizations, notably in terms of a trend toward informality. Information flows are more personal. They reflect more distributed patterns of organizational control. They foster innovativeness and creativity. They engender more widespread patterns of collaborative work. They are also marked by increased levels of disagreement or conflict [17].

Electronic communication technologies are vehicles of change in that they offer the capability to overcome constraints on time and distance which are key barriers around which organizational forms traditionally have been designed [8]. Closely related is the decline in administrative support staff and the resulting "leaner" organization. In the current movement toward a service-based society, horizontal coordination can be achieved through the use of electronic communication technology. Virtual organizations in which individuals working out of physically

dispersed workplaces have become a reality. Electronic data interchange results in very tight coupling between buyer and supplier. Electronic communication technology facilitates strategic alliances between organizations across diverse industries such as banking, travel, insurance, and telephone companies. The result is a circular value chain and new forms of interdependence.

Interorganizational systems supported by electronic data interchange technology tend to make outsourcing to reduce investment in internal information specialists and management complexity. This is one explanation of why IT results in smaller organizations [21].

The consequences of electronic communication are not all positive. Junk mail, information overload, and magnified errors in communication are examples of negative effects of electronic communication for the organization [7]. Experiments have shown that in electronic group mail the immediate job relevance of any particular message for any particular employee could be low [7]. Also, excessive tele-communication technology may not be cost-effective for some organizations [32].

As organizations move from the industrial to information age, every middle- or large-sized organization has an information organization [6]. In the near future of the information era, organizations would be structured around new organizational entities such as a knowledge/learning center, a recovery/development center, and a leadership institute [22].

### 4. The role of information technology in organizations

The role of IT in organizations is perceived differently from study to study. While the presumption that IT is the motivation of organizational changes is prevailing in the information community, many researchers provide a moderate view of the role of IT.

Several research papers investigated the relationship between organization characteristics and information strategy and information system structures (e.g., [9,13]). The premise of their research work is that the use of IT is always based on the needs of an organization and the nature of information systems varies depending upon the particular form taken by the organization.

Information is intimately linked to power-knowledge relations. Culture, control, and competition as the constitution of subjectivity determine the locus

of IT development and applications in the organization [3]. IT does not determine organizational forms and labour processes; rather, IT often reproduces complex political processes [16]. The difficulties encountered around the development of IT systems are struggles over resource allocation and career advancement within management. These activities necessarily generate potentially painful consequences for actors involved in IT development in the organization. Strategies of IT development are discovered accidentally, and then are a complex product not in the consciously planned way that practitioners intend when seeking to control IT and their own careers. IT developments often arise from and reproduce complex political processes. In these processes managers exercise their power to define market and other priorities to advocate particular IT strategies and protect certain managerial identities [16].

The major contributions of IT to organizations are still viewed as improved efficiency through speed of processes and quality of service, organizational boundary spanning (handle relations with the environment), and co-ordination of the relations among organizational units [23]. IT is often the catalyst for reengineering projects that result in greater outsourcing and leaner internal staffing. As a general result, firms investing heavily in IT are significantly smaller in staff size while holding other measures of size (e.g., revenues) constant [2].

Empirical evidence shows that a shift of organizations might be underway. However, the emerging theories of organizational transformation often neglect the “bootstrap” mechanism required to initiate and develop the shift – the explicit pathway of actions to make the logical presumption real. IT alone will not perform the bootstrapping role, but plays a catalytic role [26]. There are two circumstantial conditions in which mass electronic communication technology (Internet) could spark changes in organizations from bureaucratic to market oriented relations. One is the professional nature of occupational communities. The members are likely to have strong search behavior among social networks to facilitate a career development and professional challenge. The other circumstance is the prevailing objective of organizations towards reducing costs and maximizing profit [26].

Information policies are among the last things to change in an organization changing its culture. Increased information flow seldom leads to the elimination of a management layer or a greater willingness to share information. It is a myth that IT stimulates

information flow and eliminates hierarchy [5]. Information flow does not make an organizational culture less hierarchical and more open; rather democratic culture makes possible democratic information flows. Unless the politics of information are identified and managed, companies will not move into the information age, and information will not be shared freely nor used effectively by decision makers [5].

## 5. Centralization/decentralization in the information era

“Is the net effect of the use of computer-assisted communication and decision support technologies to increase centralization or to decrease it?” This is the wrong question to ask. In terms of organizational levels for a particular decision, for a highly centralized organization, use of advanced IT leads to more decentralization; and for a highly decentralized organization, use of advanced IT leads to more centralization [12]. However, advanced IT will eliminate employees as well as managers who are only relays.

Based on an empirical study, Wijnhoven and Wassenaar [34] concluded that IT is useful in realizing more centralization and impersonal control. Professionals in organizations are pleased with operational information systems, because they eliminate tedious jobs and organization bottle-necks and give them opportunities to do their work in a better way. This is very different from the experiences of non-professional workers who meet with more routinization, rigidity and job dissatisfaction.

An empirical study showed that mechanistic organizational design with high centralization, high formalization, and low complexity can expect management effectiveness of end use computing [1]. If the management effectiveness is one of the major concerns in IT management, this finding can be used to speculate on the impact of IT on organizational design. End user computing is more likely to result in a high centralization management style in which IT support staff is integrated in well defined tasks.

Organizational restructuring is often implemented through *ad hoc* managerial strategies triggered by financial imperatives. Whilst IT plays a part in the restructuring process, there are complex environmental and internal influences on organization structure. In an empirical study based on a survey of a couple of hundred private and public sector organizations, Currie [4] concluded that information technology does

not necessarily result in decentralized or flat organizational structure; rather, decentralization may lead to poor service levels, increased costs and reduced management control.

## 6. Information technology management strategy

A recent empirical study concluded that “competitive advantage through IT” is used as a slogan by academics seeking to respond to all of the business ills [25]. Although IT has been identified as a competitive force for a long time [27,28], little empirical evidence supported this view. The study also suggested that there is no difference in the development of IT between the manufacturing and the service oriented companies in terms of strategic reason [25], at least in Canadian industries. While a significant proportion of companies are committed to support IT at a top management level, there is a lack of alignment of IT with the external environment in most companies. However, there is strong evidence to suggest that organizations are firmly committed to the use of IT particularly in their internal operations.

For most organizations, the implementation of IT has been a matter of necessity, rather than a free choice. With competitors and suppliers installing electronic data interchange systems and global communication networks for customers, a failure to install competitive systems can mean bankruptcy. The information industry continuously drives organizations to upgrade software and hardware in the workplace. Faced with the need for rapid installation and frequent upgrades, many organizations have little time to think about the value of IT [31].

## 7. The role of information technology in organization design

Based on a discussion of methodologies of organizational design, Stebbins et al. [29] suggested that IT is a powerful tool for organizational design. Information is a part of basic work flow and facilitates the managerial control mechanism. IT can aid the operation process. It should be included during an examination of the environment, the organization’s strategies, goals, and decision systems.

Effective organizational memory can result in increased organizational learning, increased autonomy, integration of organizational actors, and lower transac-

tion and turnover cost [11,33]. Organizational memory information systems supported by advanced IT can facilitate organizational learning [30].

Lucas and Baroudi [18] provide a strong view of IT enabling for organizational change by adding the IT dimension to organizational design. New prototypical organization forms in the IT era include virtual organizations, negotiated organizations, and vertically integrated conglomerates. Their work represents a main stream of perspectives in the information systems field that IT enabled organization transformation is primarily driven by electronic work flow design/redesign.

## 8. Summary of the survey

There are certain effects of information technology on organizations. These effects include the changes to the communication mode in the organization and the creation of an electronic environment for cooperative work teams. In fact, information technology has become a fundamental variable for organizational design. However, the literature does not fully support a revolutionary view of the impact of information technology on organizations in terms of creative destruction of the organization. What we found behind this is the fact that information technology has not changed much of the social culture in terms of control, values of information technology, and competition. In most organizations formal role structure, chains of command and spans of control are still seen to follow naturally from the assumption that there is “one best way” to organize labour as well as knowledge workers. In the organizational scope, information technology is still viewed as little more than another kind of new technology for improving productivity and reducing costs. Organizations maintain their competitive power by struggling to secure a share of resources and by diminishing risks.

## 9. A model of the migration of organizations in the information era

The preceding conclusions from the literature review are compatible with our general observations of several organizations which are well exposed to IT in the private sector and utility industries. Our experience has identified a three-stage model to describe the migration of organizations in response to the chal-

lenge of IT. According to this model, an organization first experiences a knowledge link, then works on business process reengineering and implements a transaction link, and finally it actualizes a business alliance link with other organizations. The outcome of the migration is a mixture of a hierarchy of supervisory relations and networks of work teams in the organization. This new dominant form of organization functions with the support of IT. As will be seen in further detail, this model is essentially descriptive.

Before the migration model is discussed in detail, a graphic tool for conceptualizing organizational forms is presented. According to Keidel [15], when team network becomes a critical dimension in organizational design, a triangular framework which consists of control, cooperation, and autonomy can be more effective than other traditional tools for the presentation of characteristics of organizations. The original purpose of Keidel's framework is to aid organizational design. In the present study, we used the graphic tool merely to show how organizations migrate in the IT age. A slight modification of the tool was made for our purpose. In the modified triangle, the variable *control* represents the formal structure in the organization to reflect the relationships of managerial control, roles of resource allocation decision making, and hierarchy of pay and promotion. The variable *cooperation* denotes the task teams in the organization. It represents the work relationships between the employees in less formal groups. The variable *individuals* symbolizes the intensity of the involvement of organizational communication and exposition of IT. A typical organization in the current semi-information economy can be depicted in Fig. 1(a). The formal control structure is a hierarchy. Cooperative task teams are usually formed in the R&D field but with a limited scope. Organizational communication is conducted between individuals within the managerial hierarchy, and is more likely to be formal.

Next, the three-stage model is discussed further and illustrated by the triangular graphic tool.

## 10. Knowledge link

In the IT age, an individual who contributes value by adding or interpreting information is called a knowledge worker. During the early stage of the exposition of advanced IT, knowledge workers in the organization not only form informal communication networks internally within the organization, but also

share information from world wide networks such as the Internet. These knowledge workers are virtually linked each to the other and share their knowledge.

Knowledge workers learn advanced IT such as office automation, client-server database, and sophisticated software both inside and outside the organization. This in turn stimulates their demand for more advanced IT to support their work. At the same time, they seek more opportunities for career development. The organization is faced with a dilemma. On the one hand, the organization needs to devote more resources to build the information infrastructure and upgrade software and hardware. On the other hand, it must maintain competition power to reduce costs.

In the knowledge link stage, the communication channel is wide open to all knowledge workers. However, practical applications of IT in the organization remain little more than word processing for secretaries, isolated databases for bookkeepers, and spreadsheets for individual managers. In terms of control and cooperative task teams, organizations in this stage have changed little. Using the triangular tool, organizations in this stage can be described as shown in Fig. 1(b).

## 11. Transaction link

An organization will not truly benefit from IT until business process reengineering takes place. The purpose of business process reengineering is to eliminate redundant processes and creating more efficient and effective units by using advanced IT. The initial idea of business process reengineering can be generated by any enthusiastic manager, professional or consultant. However, a business process reengineering project will not be implemented successfully until top management makes a commitment.

Our observations reveal that companies often implement business process reengineering projects by forming cooperative task teams, instead of changing their formal organization structures. A cooperative task team is organized by high level management. The head of a cooperative task team is usually a head of a department which is supposed to play a major role in the task. A task is usually a cross-departmental integration of business processes. For instance, a telemarketing group makes the company more customer oriented. Sales people actively contact a variety of customers to sell the company's products. Sales people not only deal with customers' needs, but also are

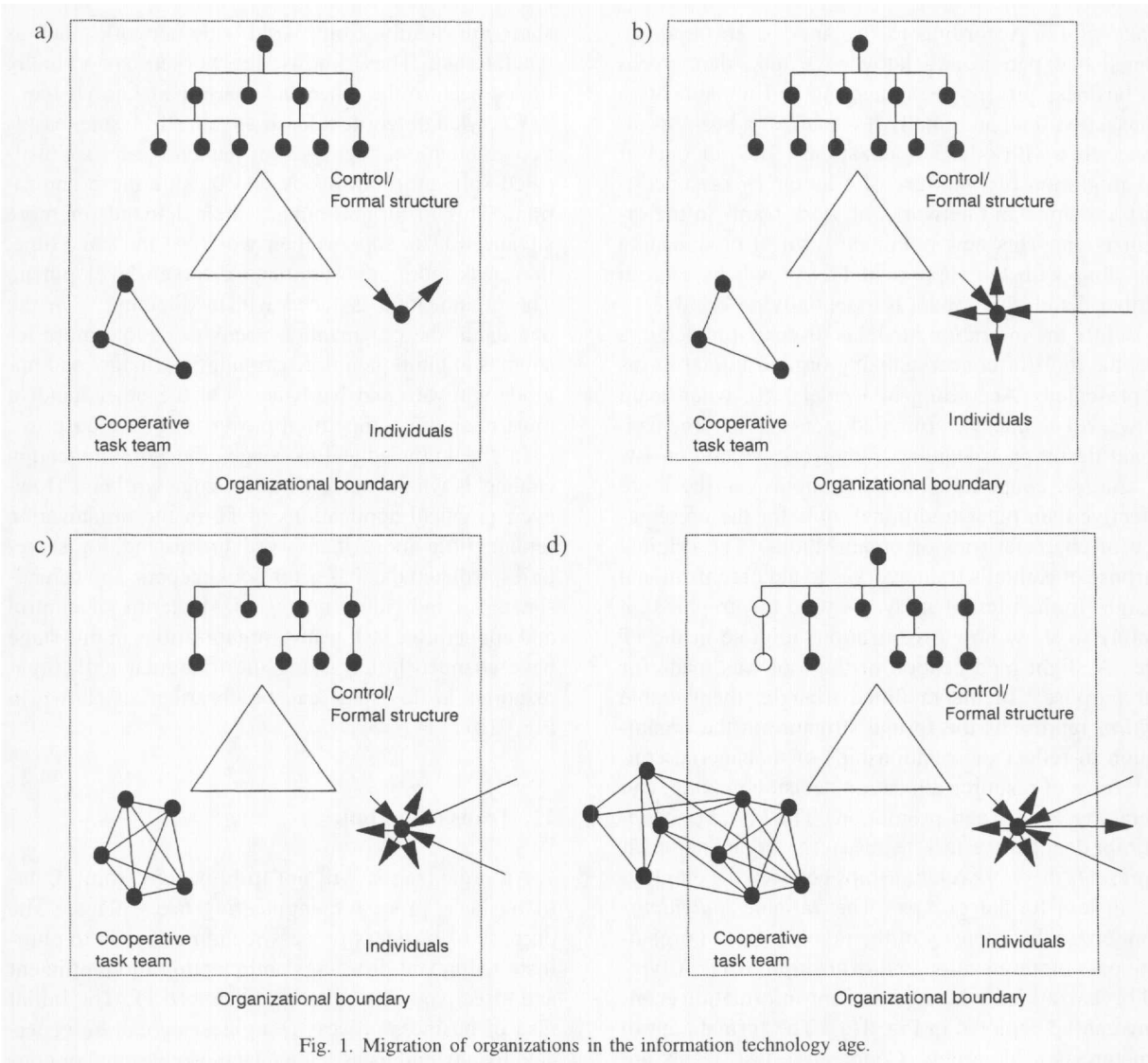


Fig. 1. Migration of organizations in the information technology age.

connected to the warehouse and accounting department directly. Now the tele-marketing group consists of sales people, warehouse managers, and accounting clerks. Supported by IT, order process, invoicing, shipping scheduling, inventory process, and account receivable process can be completed within seconds upon a sale event. The cooperative team network makes the transaction fully integrated. Organizations in this stage experience a fundamental shift from knowledge link to transaction link.

Organizations might enjoy the benefit of a downsize in the transaction link stage. However, few organizations can expect to have a significant cut in their work force. Rather they reorganize and train work teams to fully use their human resources and reduce the risks

of conflicts with unions and local communities at the same time.

A firm in the transaction link stage has the opportunity to redesign its organization in terms of job descriptions, promotion schemes, and strategies, and even the entire structure. However, there is a lack of theoretical rationales as well as practical evidence that organizations in the IT age would better change their control schemes in general.

Although the hierarchical fashion of the formal managerial control structure seems to be the same for most organizations in the transaction link stage, the role of management has been changed significantly due to the mixture of cooperative team networks and formal control hierarchy. An upper level manager might not be able to provide full supervision

for his/her subsidiary employees due to the dynamic nature of cooperative team networks, but he/she must be able to evaluate their performance. His/her role is more or less like a coach.

In this stage, interaction between knowledge workers is increasing continuously. However, communication is no longer limited to the contribution to individual knowledge; rather, it is primarily devoted to the transactions of the organization. Due to the disposition of the transaction link, the immediate job relevance of communication messages can be high.

Using the triangular tool, organizations in this stage can be described as shown in Fig. 1(c).

## 12. Business alliance link

To fully exploit the advantages of IT, organizations must expand their cooperative task teams to interorganizational networks supported by electronic communication. The immediate benefits of interorganizational networks are the efficiency and cost saving in transactions related to the participant organizations in the networks. An apparent change in the participant organizations of interorganizational networks is the phenomenon that cooperative task teams cross over the boundaries of individual organizations. A long term effect of interorganizational networks is the strategic alliance between the participant organizations. An organization migrates to the business alliance link stage once the interorganizational networks become a strategic necessity.

Electronic data interchange (EDI) is a typical example of a business alliance link. For instance, the point of sale (POS) data collected by a retailer can transmit to the wholesaler with the help of EDI. Having such data enables the wholesaler to monitor retailer's stock levels and replenish supplies faster for the retailer. Both the retailer and wholesaler benefit from the EDI by sharing information about the market segments and providing more sophisticated service to the consumers.

The success of a cross-organizational team depends not only on the group members, but also on the commitment of corresponding top management. Contract-like ties of a multiple organizational task team may range from legally binding to informal agreements. Trust between the participant organizations is essential for a successful interorganizational task team.

Knowledge workers participate in cooperative task teams in a competitive interorganizational and/or in-

ternational environment. Self-learning is a must for them to accumulate knowledge and improve skills. Quality personnel become more volatile for the organization and are virtually assets of the entire society. Human resource management and performance management are vital for organizations to survive. Job satisfaction and equity become important more than ever for organizations to achieve.

New entities of IT oriented sub-organizations, such as a learning center, can appear in many large organizations. At the same time, organizations continue to become leaner by outsourcing information functions to reduce the investment in internal information specialists. However, few changes in the hierarchical structure for formal managerial control are expected. Although interorganizational cooperative task teams blur the organizational boundaries in terms of the integration of interorganizational processes and ownership of information, participant organizations always protect their territories by tightening the central decision processes. In terms of allocations and control of financial resources and human resources, few participant organizations are willing to transfer their power to the weakly tied networks. Using the triangular tool, organizations in this stage can be described as shown in Fig. 1(d).

## 13. Discussion

The issue of organizational change and how to manage it poses a constant dilemma in the workplace. Without doubt, organizations will be affected by IT dramatically. It is a difficulty, if not impossible, to determine what is the "ideal" organization form for the future. However, we have witnessed that intensifying information flows drive organizations toward more differentiated organizational modalities. It appears that a combination of hierarchies and networks is the most appropriate structure for the majority of organizations in the modern information age.

The focal point of this view of the impact of IT on organizations is that dynamic networks formed by information-driven task forces are the fundamental components for all organizations in the information era. To facilitate organizational analysis and the design of dynamic networks for information-driven task forces, additional organizational design techniques will be necessary. Future research needs to develop a methodology for information work flow analysis for organizational design.

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