CHAPTER 1- PRELIMINARY CONSIDERATIONS AND REVIEW OF LITERATURE

1.1 Background

Businesses around the world spend well over three trillion dollars a year on Information Technology (IT) *(Forrester, 2007)*. Whether it is the implementation of an Enterprise system, or maturing the organizations infrastructure to accommodate compliance, or on the latest security appliance that has the promise to block emerging threats, most of this spend is routed through consulting services provided by firms specializing in this field. The interesting thing about IT is that if done right, it has tremendous benefits. But if done wrong, it can have catastrophic results. Murphy has summarized this in his laws – "to err is human, but to really foul things up requires a computer" and "automation of an inefficient process magnifies the inefficiency." The potential of information technology to transform businesses has been a persistent theme in both the management and information systems literatures since computers were first introduced commercially in the 1960s. Each new generation of processors and each major technological advance has been accompanied by vehement claims that businesses as we know them will be radically and fundamentally altered *(Leavitt and Whisler's, 1958)*. This has been supported by the fact that the prices of IT products (especially computers) have halved every 2-3 years. If progress in the rest of the economy had matched progress in the computer sector, it would have been possible to work for a mere ten minutes' labor and be self sufficient in terms of food for a year. Both the above characteristics can rapidly become necessities if the organization lags behind its competition in terms of technology differentiation. If this happens, then these become defensive measures that must be taken for the organization to survive. This indicates that the strategizing of IT should not take place pre or post the strategizing of business. For example, airlines that were not early adopters of new technologies like on-line ticketing systems – and more recently, web check-ins and Web transactions, found themselves losing significant business. However, even for those airlines that did adopt these technologies, the advantage was typically temporary – lasting only for the time it took for competitors to adopt the same (or improved) versions of the technology. Similar examples can be seen in the

banking, financial services and insurance vertical (BFSI). Banks that were early implementers of ATMs (automated teller machines) found that their advantage was short-lived.

There have been increasing levels of business investment in information technology equipment. These investments now account for over 10% of new investment in capital equipment by companies. Early forecasts set the stage for later speculation: Organizations would leverage their mainframe computing power to reduce middle management levels and push decision making upwards to a smaller set of executive elite. With the advent of widespread desktop computing in the 1980s, this vision shifted to focus upon a work force of autonomous knowledge workers and empowered clerical staff. During the 1990s, as computers became networked, a series of technological breakthroughs emerged – wide area networks, enterprise software, collaborative computing – that actually transformed the business world. Within and across organizations, predictions of "virtual organizations" emerged. More recently, the Internet has spawned yet another set of projections for electronic commerce among organizations without geographical limitations and "intelligent systems" within them. Agendas of business process re-engineering have given way to broader agendas for business transformation and knowledge management, each with its own implications for revised structural forms. Thus, almost four decades following Leavitt and Whisler's speculations, information technology is seen, all the more, as a powerful force enabling radical new designs for businesses *(Galliers and Baets 1998, Hammer 1996, Lucas 1996)*, though this view has also been challenged by authors like Carr *(Carr, 2003)* who claim that in recent years, IT has been 'commoditized' and no longer contributes to strategic importance for businesses.

Until recently, the predominant logic employed in such arguments was causal – totally unaware of fuzzy logic – placing information technology in the role of an external agent capable of transforming business directly. Thirty years ago, most executives looked down on computers as basic, rudimentary tools – glorified typewriters and calculators – best left to clerical employees like secretaries, analysts, and technicians. It was the rare white-collar worker who would let their fingers touch a keyboard, much less let information technology invade strategic thinking. Writers who described information technology as a "force," "driver," or "imperative" were telling managers that they should not adjust to the demands of this external agent of change. For example, *(Morton Scott, 1991)* argued that all successful firms would pass through a

radical transformation during the 1990s: "All dimensions of the firm will have to be re-examined in light of the power of the new IT. The economics are so powerful and apply to so much of the firm that one has to question everything before accepting the status quo." A more moderate causal relationship portrayed managers as rational designers using information technology as a means to fashion radically new designs that their businesses needed. Writers referring to the "enabling" role of information technology placed managers in the role of causal agent, triggering the "magic bullet" of information technology to transform business *(Markus and Benjamin 1997).*

Several critical reviews have questioned the cause and effect logic underlying such analyses of the business impacts of information technology *(DeSanctis and Poole 1994, Hirschheim 1985, Kling 1980, Markus and Robey 1988, Mowshowitz 1981, Orlikowski and Robey 1991, Walsham 1993).* Drawing from various sources, these authors have pointed out that, basically, there is a more complex, non-causal relationship between information technology and business, advancing concepts such as fuzzy logic, and promoting interpretive research methods. These suggestions have influenced recent studies, and have produced more elaborate analyses of business transformation. Professional management literature also highlights greater sophistication of arguments, rejecting the causality approach of earlier work on the transformational potential of information technology *(Galliers and Baets 1998, Markus and Benjamin 1997, Sauer and Yetton 1997).*

1.2 Objectives and Questions

The objective in the present work is to map the advances in information technology for companies and organizations in a cross section of verticals. To achieve this objective the following two things are done: (a) the nature of business transformation is described and analyzed through the use of information technology tools and techniques, and (b) the major trends in this transformation are identified. A good insight into (a) and (b) equips the researcher to achieve the defined objectives.

This work proposes to show that organizations are moving towards Enterprise Integration. Enterprise Integration is the integration of processes across organizational and functional boundaries to provide competitive advantage. The process of achieving Enterprise Integration includes all managerial and technological factors that enable cross-functional process

integration. The end result is a customer-oriented management structure with information systems that are formally linked to processes and the integration of processes needed to establish/retain customer satisfaction.

Some of the other questions this research seeks to address are:

- As businesses consolidate and integrate around their core competencies, do they tend to outsource more? Is this desirable?

- Do business cycles have an effect on the developments in information technology?

- To investigate how the very nature of business has been transformed through the use of Information Technology tools and techniques -

    i. In terms of transactional ability
    ii. In terms of competitiveness
    iii. The economic reasons for this shift
    iv. Impact on workers
    v. Security and vulnerabilities

- To indicate trends in this transformation. Trends would broadly be in terms of:

    i. Cost–performance structures
    ii. Architectures
    iii. Platform features
    iv. Security threats and countermeasures
    v. Enterprise application integration
    vi. Enterprise management
    vii. Business continuity

- To attempt to answer the question whether this transition can be controlled.
- To examine how this transition has impacted the workforce in these businesses.
- To construct a model framework for a business to succeed in this global, competitive world by effectively utilizing IT to enhance its core business competencies.

1.3 Structure of Work

This work is divided into the following six chapters:

I. Preliminary Considerations and Review of Literature – Statement and context of the problem: The current chapter includes (a) an overview of the research topic; (b) it provides a statement of the problem; and (c) a brief review of the relevant literature.

II. Nature of Business Transformation: In this chapter, (a) the strategy to tackle the problem is explained, and (b) the methodology and argument of the work is developed. I move from an inquiry into the nature of business transformation through the use of information technology tools and techniques, to indicating the trends in this transformation, and finally I endeavor to map the advances in information technology for companies and organizations to enhance their core business competencies. The methodology includes a descriptive and analytical study of some companies and organizations including those in the energy and ancillary verticals. The existing literature (journals and periodicals, the internet, and the various national and international libraries) is extensively used to determine how such companies have conducted business traditionally. Furthermore, the concrete benefits these companies have derived from the use of information technology are quantified.

III. IT Theory, Tools, and Methods–Part One: In this chapter, the salient features of theory, tools, and techniques that are exploited in the thesis are explained.

IV. IT Theory, Tools, and Methods–Part Two: In this chapter some concrete examples are considered and analyzed is presented in detail relevant to the purposes of this work.

V. Case Analysis: In this chapter, a case analysis of nine companies is done to qualify the research objectives. These nine cases are based on three cases each of three

consulting companies having a presence in India, having a domain specialization in the Energy and allied domains.

VI. Results, Conclusion and Looking Ahead: In this last chapter the results of the work, its significance, and also its applications are clarified. The findings are rounded up and further work prospects are suggested.

1.4 Review of Literature

From a historical viewpoint, the driving force behind the adoption of any technology has been its potential for transforming the way people and organizations live and work. Nowhere has this been more evident than in the progress of information technology (IT). The world has made more progress in this area in the last fifty than in the last five thousand years. *(Hall R., 2002).*

Business does not live within the "brick and mortar" confines of the enterprise, but it breathes in the whole web of relationships among employees, customers, business partners, suppliers, shareholders—all those on whom the enterprise relies for growth, development and success. Yet in the heterogeneous environment that evolved through the years from competing architectures and operating systems, these relationships were not touched in any integrated sense. This made business fragmented, and resulted in setting up isolated "islands of automation" *(Alexander, Ernest R. and Gordon and Breach)* with discontinuous implementations of information projects.

The response of economies in general and the changing business environment is one driver of business transformation. While some organizations reacted through downsizing or re-structuring, others have dealt with competitive pressures by using enabling IT and systems. Even though some would argue for the point, others don't see technology as the driver. The transformation that is discussed throughout this work is fundamental in nature – focused both internally to the firm as well as externally – from the firm to the industry and in turn, the economy.

It is primarily these factors that have led some authors to hypothesize that the information age is an entirely new age. For example, Dertouzos *(Dertouzos, Michael L., 1991)* states: "The agricultural age was based on farming innovations and implementations – primarily labor intensive; the industrial age moved towards capital intensiveness by using engines and machines. Similarly, the information age will be based on IT resources and global networks that interconnect them." The implication is that we are experiencing a new information revolution, one that is as dramatic as the agricultural and industrial revolutions. Furthermore, the effects of this revolution have been uneven, having a dramatic impact in some countries and relatively little in others – though this is now unifying and one can say that some countries have experienced the impacts of IT before others. An example in this context is the Indian Railways – which was largely unaffected by the Y2K problem since they were not automated to a great extent.

These changes and impacts predominantly have been made possible through standards based technologies. Since 1969, in the academic community of various teaching and research institutions, the Internet had been germinating out of public sight. Not long after the development of the World Wide Web in 1991 and later Mosaic, the first graphical user interface for the Web, business began to see the Internet's technologies and standards as ways to connect and integrate all the information systems in which it had invested and was using as tools to further business. *(Bensaou, M., and M. Earl, 1998).*

Businesses thus began integrating Web standards and technologies into their existing information infrastructure. This caused a new, extended infrastructure to emerge along with a new 'virtual' business model based on the ability to reach anyone inside or outside an organization any time of the day or night. The transformation to e-business has been revolutionary, dramatic and is still continuing with tremendous potential and far reaching results.

Penzias *(Penzias, Arno. Harmony, 1995)* hypothesizes that we are poised on the verge of a second information revolution. Despite enormous progress, modern technology still falls short of fulfilling human needs – for example, harmonizing technology with people, with nature, and with itself remains a challenge.

According to Penzias, we can concentrate on 3 primary periods to illustrate this:

- The era of quantity,
- The era of quality, and
- The era of harmony.

The first of these – the era of quantity is associated with the mass production archetype of the industrial revolution. The second – the era quality is associated with the last 3-4 decades. Here, the focus is on product quality in order to achieve competitive advantage. While different industries and companies will conform to different time horizons in their transition from one to the other, Penzias suggests that most have already transitioned from the quantity to the quality era, and are currently transitioning from the quality to the harmony era – i.e. a shift of the focus from individual products to integrated service, with each customer becoming a partner in value creation by participating in "design" at the point of sale. This transition will bring greater consistency to the value-creation process, with technology becoming more aligned with its users and with the surrounding environment.

The above translates to a future in which organizations work together with their suppliers and customers to add value to their products. This means a regime in which quality is expected, with an additional focus on convenience. Customer feedback – which was a key feature of the quality era, is replaced by personalization - i.e., producing to customer order with possible lot sizes of one. This level of co-ordination among customers, suppliers, and firms can be facilitated only by integrated processes supported by strong integrated information systems.

As the use of IT becomes more and more ingrained in business, the nature of work and commerce undergoes mutation. Some examples can be cited: The innovative use of web technologies enables companies to establish geographically disparate networks that link employees and bring together the diverse sources of information within an enterprise. Lockheed Martin Corporation and The Boeing Company, collaborating over an intranet, developed the Darkstar aircraft in a short period of eleven months with only fifty people. *(Cross, John & Earl, Michael J, 1997).* Earlier the process usually required hundreds of designers and years of work. If these networks are based on the same protocols as the Internet, they are called intranets – and these can be transformed to extranets connecting a firm to all its trading

partners by simply granting appropriate access controls. These internal and external links are delivering what was thought impossible a short time ago: efficient, timely collaboration within the enterprise and between companies separated from each other by geographical distances and time zones.

For the first time, a global conglomerate, and its trading partners, can act as a unified, global team, because workers can leverage a shared base of knowledge accessible, made available, and delivered from anywhere in the world. A combination of intranets and extranets enables ABB, the Swiss transnational, to integrate over 60,000 users in a worldwide corporate network spanning more than 80 countries and to connect over 100 external companies - both customers and business partners. *(Earl, Michael J., 1994).*

The global reach made possible by these technologies for heretofore local companies has startled other, bigger firms that thought themselves established in their markets. All this is good news for the customer, who with the use of the Web, power is migrating to the buyer who, armed with a great variety of information on price, quality, and availability, can now easily compare a global universe of suppliers.

These changes are likely to have changes at the organization structure level as well. Penzias states that integration is the prime motivator facilitating the transition from the era of quality to the era of harmony. Integration and direct information access, the two components of the harmony era, greatly reduce paperwork and dependence on manual processes, which provides an indirect benefit to the customer by cutting down on time as well as increasing accuracy, and will consequently reduce the positions that were centered around it. He notes that the leaders of the future will be those who have the skills to make technology more accessible and user-intuitive or cost effective – Google is a typical example of this phenomenon.

Out of the many benefits and transformation brought about by the internet, one of the most exciting is the high level of personalization facilitated by this new medium. *(Blundon, William, 1997)* While earlier, product design used to be based on averages of customer enabling the product to appeal to a mass market. In current day scenarios using contemporary technologies like data warehousing and mining, colossal amounts of information can be processed and made available to an e-business – thus enabling targeted marketing campaigns and demand

creation based on customer preferences. Thus, instead of ending the relationship with the transaction, the relationship with the customer can be extended over his entire lifetime through database technologies that can effectively build a dossier of each person's needs and wants – with information available in an instant. This is leading to brand differentiation based on knowledge of the customer instead of the more traditional ones of price and quantity.

The e-business transformation appears to be ever-growing. There are many powerful forces to drive it forward. Some of these are:

- Aided by secure electronic transactions, companies are automating and integrating all their business processes from the customer at one end to the suppliers at the other. In such an environment, one transaction (effectively one click) by a customer can trigger multiple related transactions throughout the organization. As a consequence, the next generation of transaction processing being built on scalable, reliable, manageable, and secure infrastructure is emerging.

- Collaboration technologies are bringing employees together across geographical and chronological boundaries, thus making them more effective, responsive, and innovative. Additionally, knowledge management is already making distributed learning a reality, and soon synchronous communications will make real-time video collaboration available for education, training, and general e-business communication *(Burdon, S.,1999)*

- Powerful number crunching applications, directly descended from Deep Blue (an IBM supercomputer noted for its chess-playing ability) are already being used to transform information into useful, valuable knowledge. An example here is the New York Times online edition, which is the world's first case to target advertising to precisely the right people. *(Hagel, J. III, and J. S. Brown., 2002).*

- Ubiquitous computing is in the process of "Web-enabling" everybody and everything that can benefit from IT. Everything from mobile phones to cars and refrigerators can be connected to the Web and automated to one degree or another. *(Earl, M., and D. Feeny, 2000).*

- Digital media is enriching the Web experience with video, sound, graphics, animation, and all sorts of effects. This is making the internet reach more and more people thus furthering its accessibility and easy usability.

All this will require a renewed Internet infrastructure, phenomenally reliable and secure, maybe a hundred to a thousand times faster than the Internet today, providing the most sophisticated applications imaginable. In fact, these technologies will become so thoroughly integrated into our lives that, more than business, society itself will be transformed - our day-to-day lives (whether personal or professional) will be automated to a degree undreamed of in the past. One has to keep in mind, however, that in a business (as in life for that matter), few individuals are enthused by the prospect of being surrounded by technology, although the fact that the technology driven potential for transformation is tremendous. However, what does enthrall people is the potential for transformation.

This brings us to the fundamental question - How does IT contribute to business performance and economic growth? Even today, most people who are asked to identify the core strengths of micro-processors tend to think of number-crunching, compute intensive tasks like rapidly finding large prime numbers. Computers have excelled at computation since the Mark I (1939), the first modem computer, and the ENIAC (1943), the first electronic computer without moving parts. During World War II, the U.S. government generously funded research into tools for calculating the trajectories of artillery shells as well as for simulations of various kinds – including weather and CBW (chemical-biological warfare) dispersal and spread patterns. The result was the development of some of the first digital computers with remarkable capabilities for calculation—the dawn of the computer age.

However, computers are not fundamentally number crunchers. They are logical symbol processors. The same basic processors can be used to store, retrieve, organize, transmit, and algorithmically transform any type of information that can be digitized—numbers, text, rich media including video, music, speech, programs, and 3D simulations, to name a few. This is fortunate because most problems are not numeric in nature. Reservoir simulation, oil spill modeling, basic accounting, and parts of other tasks involve a lot of calculation. But the everyday activities of most managers, professionals, and information workers involve other

types of thinking as well. As computers become cheaper and more powerful, the business value of computers is limited less by computational capability and more by the ability of executives to invent new processes, procedures and organizational structures that can leverage this capability. Chief executives now routinely talk about the strategic value of information technology, about how they can use IT to gain a competitive edge, about the "digitization" of their business models, and actively seek the awareness and knowledge to harness this new power at their disposal. As complementary innovations continue to develop, the applications of IT will expand well beyond computation for the foreseeable future.

The fundamental economic role of computers becomes clearer if one thinks about organizations and markets as information processors *(Galbraith, 1977; Simon, 1976; Hayek, 1945).* Most of our economic institutions emerged in an era of relatively high communications cost and limited compute capability. Information technology, defined as computers as well as related digital communication technology, has the broad power to reduce the costs of coordination, communications, and information processing. A prime example is the emergence of the VoIP – Voice over IP (internet protocol) standard that is fast replacing traditional circuit switched telephone exchanges worldwide. Thus, it is not surprising that the massive reduction in computing and communications costs has engendered a substantial restructuring of the world's economy. The majority of modern industries worldwide are being significantly affected by computerization. India is no exception to this.

In the light of the above mentioned developments, information technology is best described not as a traditional capital investment, but as a "general purpose technology" *(Bresnahan and Trajtenberg, 1995)* – one that I like to call 'ubiquitous'. In most cases, the economic contributions of general purpose technologies are substantially larger than would be predicted by simply multiplying the quantity of capital investment devoted to them by a normal rate of return. Instead, such technologies are economically beneficial mostly because they facilitate complementary innovations. Earlier general purpose technologies, such as the telephone, the steam engine and electricity, illustrate a pattern of innovations that ultimately led to stupendous enhancements in the then levels of productivity. Some of these innovations were purely technical, such as Ted Hoff's method to put circuits for computing on a piece of silicon.

However, some of the most interesting and productive developments were business transformations. For example, the improved methods of transportation like the railroad facilitated the formation of geographically dispersed enterprises *(Milgrom and Roberts, 1992)*; while the electric motor provided industrial engineers more flexibility in the placement of machinery in factories, dramatically improving productivity in manufacturing by enabling shop-floor redesign *(David, 1990)*.

In reviewing the evidence on how investments in information technology are linked to the transformation of business coupled with higher levels of productivity, with emphasis on studies conducted at the micro level, one of my central postulates is that a large part of the value of IT lies is its innate ability to enable changes in the way organizations work – such as in business processes and inter-relationships between organizational entities. Further, these investments, in turn, lead to huge improvements in productivity by not only reducing cost but more importantly, by enabling firms to increase output quality – either in the form of completely new products, or by improvements in the subtle aspects of existing products in terms of convenience (using web technologies), timeliness (using interactive voice response systems) and quality. There is a large amount of evidence in both the case literature on companies and multi-conglomerate econometric analyses supporting both these postulates. The emphasis on micro-level (organization level) evidence originates partly from my own research focus but also because such analysis has significant quantifiable advantages for examining the otherwise intangible organizational investments and product and service innovation associated with IT.

The components of such analysis are difficult to determine through the traditional macroeconomic approaches. In the course of my work I develop and present a model to assess the impacts of IT on critical business activities across the entire value chain. The model is based on the vision, mission and corporate goals for organizations based on actual IT implementations and applications that worked. I also highlight the areas that enable or hinder IT and business synergy. I do this in the context of consulting firms (encompassing both IT and Management consulting firms) that operate in the Oil & Gas, Energy or Transportation space. My work brings out the salient features of how these firms have performed over the

last few years and what are the areas they have focused on in order to make their clients enhance their core competencies.

The components of such analysis are difficult to determine through traditional macroeconomic approaches. As a result, the economic contributions of IT are likely to be underestimated in macro-level analyses. Placing a precise value to this is difficult, basically because of the complex inter-relationships of firm-level profits impact the industry, the economy and society as a whole. My analysis shows that the returns on IT investments may be substantially higher than what is suggested by the traditional growth accounting theories. To elaborate, mathematically –

$$Q = A\ L \times K\ y \quad \text{where}$$

K: the total stock of capital (for example, buildings and machinery) available.

L: the size of the labor force

A: Known as the productivity available, and is computed from technology and efficiency.

Further, the total stock of capital (including intangible assets) associated with the computerization of the economy may be understated tenfold. Taken together, these imply that the margin of error could be on the same order of magnitude as the measured benefits of IT. A further attempt is made to demystify the relationship between IT and business and attempt to measure the quantum of social linkages.

Based on the above, while macroeconomic evidence about contributions attributed to IT may be encouraging, I prefer to focus on the microeconomic data – which suggests that the increase in productivity that is manifested in macro level statistics has its origin in the last thirty years of organizational investments in IT. Today, no one would dispute that IT has become the backbone of commerce everywhere. It provides synergy to the operations of organizations, ties together geographically dispersed supply chains, and, bridges the gap between the organization and its customers. IT enables the transfer of funds between persons, companies and economies worldwide. In fact, it is difficult to conceive such transfers without the application of IT.

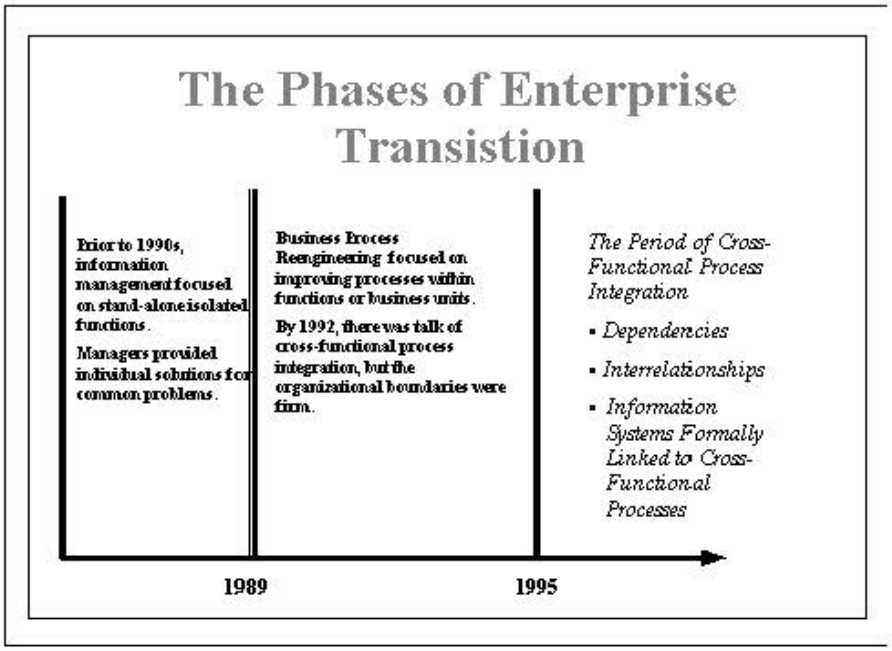
Successful firms that use IT to change the way they do business often claim that their investment in 'I' heralds changes in other aspects of the organization. These related changes are important to understanding the value of IT investment. To be successful, organizations typically need to adopt IT as part of a "system" or "gestalt" of mutually reinforcing organizational changes *(Milgrom and Roberts, 1990)*. Incremental changes, or 'islands of automation' – either through investments in IT without business process changes, or only partially implementing some changes, can create voluminous losses in terms of productivity, as well as top and bottom lines, since any benefits of computerization are more than outweighed by negative interactions with existing practices *(Brynjolfsson, Renshaw and Van Alstyne, 1997)*. The need for absolute "1 or 0" changes between complementary systems was mainly the rationale behind the (BPR) business process re-engineering wave of the 1990s and the clarion call "Don't Automate, Obliterate" *(Hammer, 1990)*. This also explains why many large information technology projects fail *(Kemerer and Sosa, 1991)*, while successful deployments and utilization of IT results in a strategic competitive advantage in the industry, significant gains for shareholders and value for the company as a whole.

Many of the last fifty years best known for most successful business practices reflect the traditionally high cost of information and data processing. For example, hierarchical organizational structures can reduce communications costs because they minimize the number of communications links required to connect multiple economic entities, as compared with more decentralized structures *(Malone, 1987; Radner, 1993)*. Similarly, producing homogenous products is an efficient method to manufacturing process lines that are inflexible and provide economies of scale. However, since the cost of data processing and computing has decreased almost one hundred percent since the 1960s, it is unlikely that the business ethos and methods of that period will be conducive to providing returns of cheap information and flexible production. In this context, *(Milgrom and Roberts, 1990)* have constructed a model in which organizations move from generic, mass production to a flexible, diverse product line, IT based, modern manufacturing system. This is driven by continuous decreases in the cost of IT. This illustrates how changes in the costs of IT as well as its enhanced potential and applicability can lead to a plethora of changes in work culture and organizational strategy. Obviously this results in an increased demand for skilled human capital.

1.5 Phases of Enterprise Transition

It is proposed to present cases using simple examples that relate to the phases of enterprise transition that are presented in Diagram 1.1.

Diagram 1.1 - The Phases of Enterprise Transformation

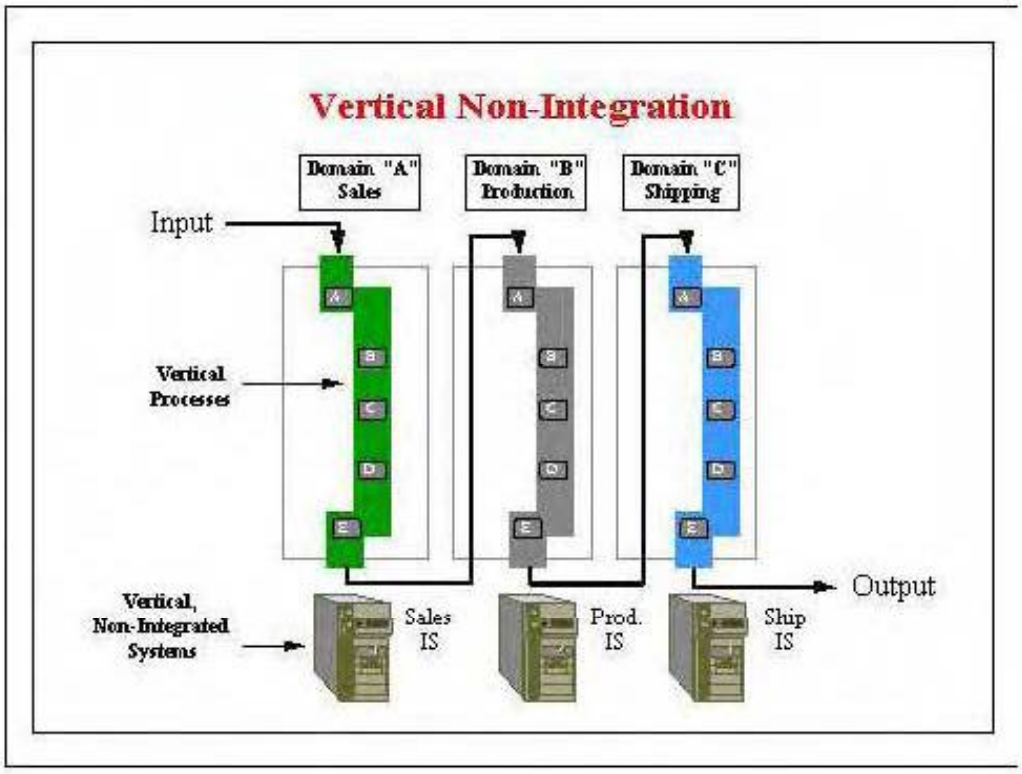


1.5.1 THE PERIOD OF ISOLATED STAND-ALONE SYSTEMS

Before the 1990s, the information needs of a firm were typically met by vertically aligned information systems that supported specific domains. Consider the simple example that is presented in Diagram 1.2. Three domains – sales, production, and shipping are shown in this figure. In the initial days of automation, it was common to have a separate IT application for each domain; i.e., "EDP" systems for sales, production and shipping. It was also fairly commonplace for there to be limited interoperability (if at all) among these systems. In fact, entire departments often existed only for purposes of transferring information from one system to the next.

Naturally, because of this dichotomy, any customer while placing an order would not have adequate or accurate information about the availability and delivery at the point-of-sale. This inability, besides adding to time to the customer order fulfillment process also increased the chances of errors and inaccuracies in the order and/or billing. This paradigm is associated with the first phase described in Diagram 1.1; the age of EDP vertically aligned information systems.

Diagram 1.2 - The Old Information Systems Paradigm



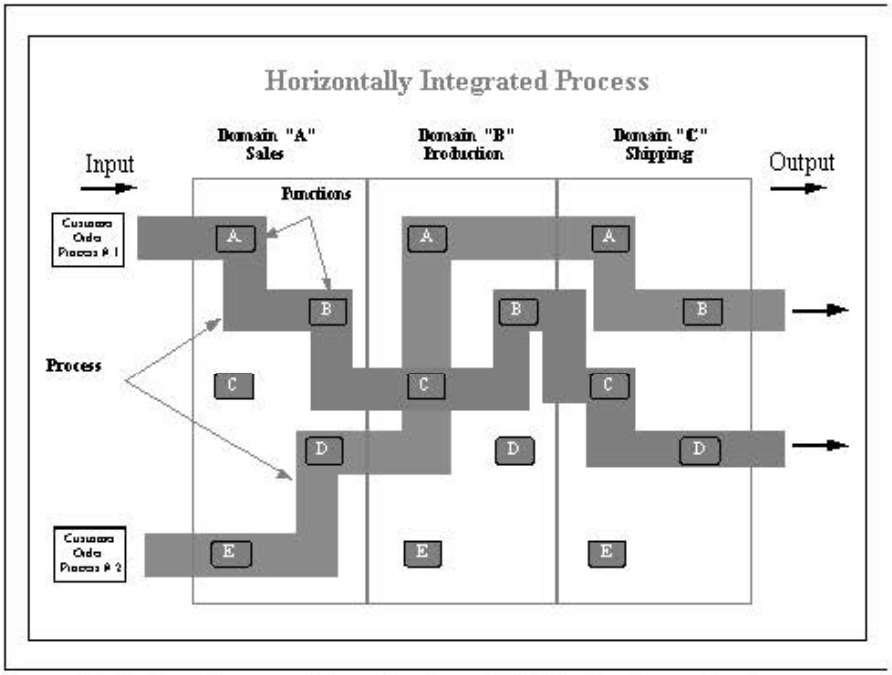
1.5.2 THE PERIOD OF PROCESS REENGINEERING

The second phase, (as shown in Diagram 1.1), came into being through the realization that if the whole thing was managed as a process, it could greatly reduce the time required to respond to a given business need; e.g., fulfilling a customer order. Hence, in order to reduce cycle-time in delivering the product to the customer, organizations shifted their focus to managing by

process as opposed to vertical "EDP" domains. In the simple illustrative example, the focus is on the customer order process. This situation is depicted in Diagram 1.3.

In Diagram 1.3, one can see that the customer order process may consist of a number of sub-processes – each of which do not contain all the individual functions within a particular domain, even though the management solution spans all three domains. This concept motivated a managerial revolution in large parts of the world during the early 1990s. This period was associated with the radical process improvement (i.e., re-engineering) of business processes within organizations.

Diagram 1.3 - Process Management by Core Process



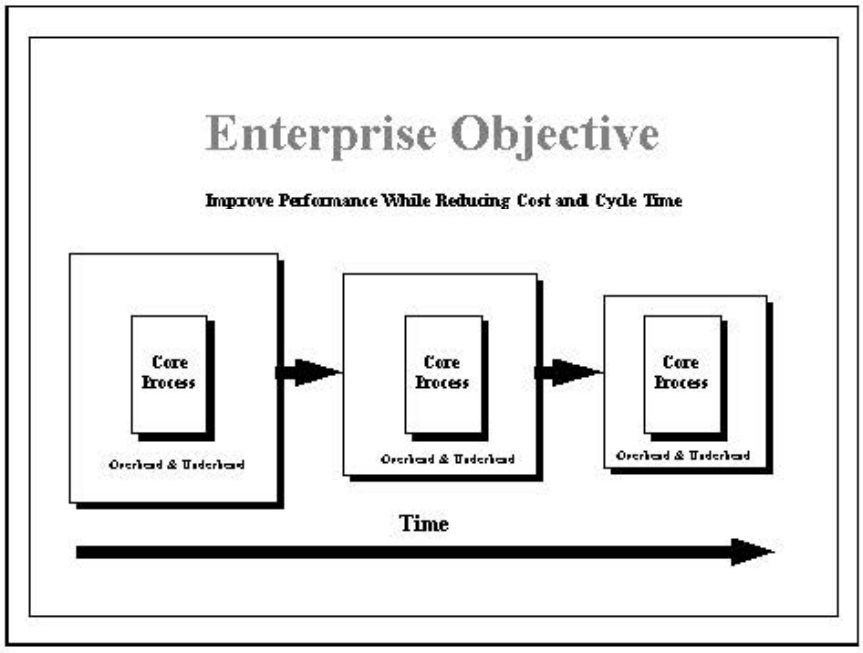
The purpose of Business Process Reengineering (BPR) is to change business processes and cultures radically by identifying and implementing new business practices. The focus is on redesigning processes with IT playing a supporting role. BPR was hyped as 'the' key to corporate survival, providing the capability to respond to rapidly changing customer expectations. The reality, however, was that many organizations used BPR as a downsizing tool to achieve cost reductions through employee headcount reduction, and had only a secondary focus on increasing effectiveness. Most organizations that adopted BPR targeted

legacy business processes and organizational structures. BPR is most often associated with the radical work of Hammer. *(Hammer, Michael and James Champy, 1993)* Alternative strategies to BPR are presented in Diagram 1.4.

Figure 4 assumes an understanding of the term 'core process' – those processes central to business functioning, which relate directly to external customers. *(Earl, Michael J., 1994)* Re-engineering basically focused organizational resources on these core processes while continually reducing overheads. The objectives were simple:

- Optimally allocate resources to "winning" products,
- Create an environment for continual change,
- Stay ahead of demand and the competition, and
- Shift resources from other corporate claimants to the core processes.

Diagram 1.4 - Organizational Resizing Over Time



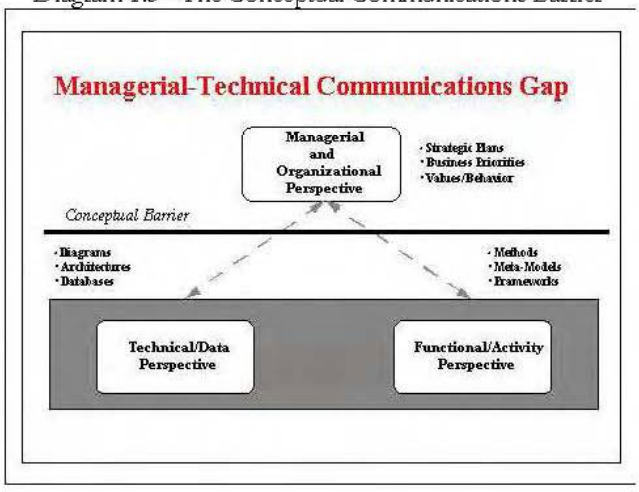
With hindsight, it can be seen that many organizations did not reap the anticipated benefits of BPR, with popular media reporting BPR failure rates as high as 70-80%. *(Earl, Michael J., 1994)* The reasons for these failures were many. However, they do not form part of the scope of the

present work and also they have been discussed extensively in the relevant literature and so are not considered here. There is a lot of work that demonstrates that such firms obtained cost savings in the short run due to the downsizing, but no long term competitive advantage. Real benefits accrued through increased competitive advantage through cycle time reduction.

1.5.3 THE PERIOD OF ENTERPRISE INTEGRATION

In the third phase – that of enterprise integration, it is useful to remember that BPR is a management strategy whose successful implementation is enabled by IT. Technology specialists don't always communicate well with business managers because they lack a common language – as illustrated in Diagram 1.5 – which is divided into two parts: a perspective that relates to senior managers (the top half) and a perspective that relates to technology specialists (the bottom half). Business executives are very comfortable communicating on business related topics such as market strategy, organization structure, financials, etc. whereas technology specialists are most conversant with technical issues like data security, data structures, flowcharts, and the like. A communication barrier exists because the two don't communicate effectively with each other; even when on the few occasions they happen to meet to talk, they fail to communicate, since they don't speak the same language. This leads to the business benefits being under-rated in many organizations – where the IT department is perceived as just another necessary cost center.

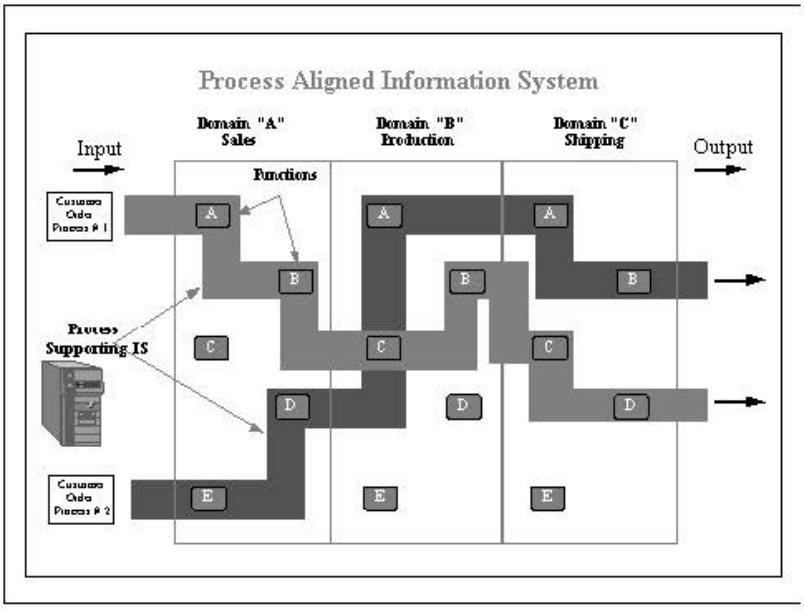
Diagram 1.5 - The Conceptual Communications Barrier



Successful implementation of BPR alternatives of the sort described in Diagram 1.4 requires this communication barrier to be eliminated so that business and IT can see eye to eye as far as the organization is concerned. Activities are embedded in processes – through which data flows; organizational entities like employees are embedded in the processes; etc. Successful implementation requires that there be a central premise whereby business defines the process and organization structure, while technology specialists define the data, workflows, and other IT related aspects. Furthermore, if business executives seek to alter embedded organizational processes (basically doing BPR) then the organizations information systems need to be re-aligned with the re-engineered processes.

Suppose the customer order process (shown in Diagram 1.3) is re-engineered and the three legacy information systems are realigned so that they support the processes as opposed to the individual domains, then there is potential for large reductions in cycle-time. This improves customer satisfaction, adds value to the organization, and reduces cost. This is especially important since it illustrates why many BPR efforts fail and why Enterprise Integration is more likely to succeed. Consider Diagram 1.6, which is Diagram 1.3 with a single modification.

Diagram 1.6 - Process Management by Core Process with Supporting IS



In Diagram 1.2, three separate legacy applications, each supporting a single domain was shown. Subsequently, as in Diagram 1.3, the domain focus was changed to a process focus. It was suggested that each process should be re-engineered to attain maximum efficiency, but complementing changes to the information systems were not considered. In fact, this was the reason that so many BPR exercises failed – when organizations re-engineered their processes, but did not correspondingly change their IT applications. Attempts were being made to manage by process, but IT applications were still providing information by organizational domain. In the highlighted example, it is not possible to provide timely order information at the point of sale, even with the new focus on process.

Diagram 1.6 resolves this situation by implementing an IT application that supports the processes, as distinct from the separate domains. This is the essence of Enterprise Integration – once the IT application is process oriented, there is no need for people to enter and validate data on the domain boundaries. And this is what would lead to transformation – through the elimination of paper-based transaction processing and redundancy in the core processes. Every person who validates, re-enters, or transfers data between functions is adding very little value to the process (if at all) – these people will be moved to other jobs or completely removed from payrolls.

In the course of the present work, I have sought to outline how the nature of transactions – fulfillment, payment, delivery, shipping, manufacturing and so on have been affected by the impact of IT and how companies have had to develop new ways of interacting with their peers, suppliers, customers and partners to remain competitive in the new global economy.

1.6 Direct Measurement of link between IT and business

Some studies have tried to measure these complementing factors directly, and to determine whether there is any co-relation with IT investment, or whether organizations that implement these complements perform better. Finding such a correlation between IT investment and business transformation, or between these complements and corporate performance, is not sufficient to prove that these complements exist, unless a full structural model specifies the production relationships and demand drivers for each factor.

There is another argument – that the first-order impacts of IT investment occur at the process-level i.e. IT creates value for the organization by streamlining individual business processes, or inter-process linkages, or both *(Barua, 1995); (Mooney, 1995); (Crowston, 1986).* The argument then goes to state that the greater the impact of IT on individual business processes and on inter-process linkages, the greater will be the contribution of IT to firm performance.

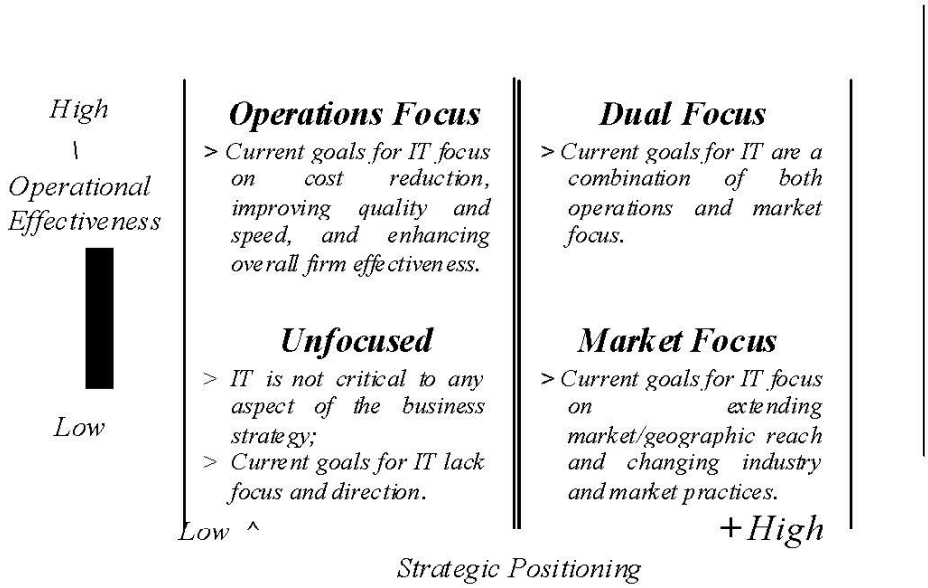
The value chain (proposed by Michael Porter) is one of the most widely known process models in the world *(Porter, 1985).* The value chain divides an organization into a sequence of activities. Products pass all activities of the chain in sequence, and at each activity the product gains some value. The chain of activities gives the products more added value than the sum of added values of all activities. The use of IT within each of these activities enhances the value-creating potential of the organization. To analyze a given industry, Porter introduces five competitive forces:

(1) the entry of new competitors
(2) the threat of substitutes
(3) the bargaining power of buyers
(4) the bargaining power of suppliers
(5) the rivalry among the existing competitors

The basis for above-average performance of a firm in a given industry is a sustainable competitive advantage, either based on low cost or on differentiation. The goal of a profit-seeking firm is to create value for buyers that exceeds the cost of doing so. Porter derives three generic strategies to achieve these goals: (1) cost leadership, (2) differentiation, and (3) focus *(Porter 1985).* Competitive advantage is not understood by looking at the firm as such, rather one needs to distinguish between the many discrete activities in a firm. Porter's framework splits the firm into the following nine core activities.

Primary activities:	**Support activities:**
Inbound & outbound logistics	Procurement
Operations	Technology development
Marketing and sales	Human resources
Service	Firm infrastructure

It is proposed that information technology allows the break-up of the existing value system and individual value chains along the lines of core competencies and capabilities. This reordering supercedes the hierarchical organization. In the above definitions, the distinction Porter makes between operational efficiency and strategic positioning can be translated directly into corresponding goals for IT. For example, efficiency is achieved by using IT to reduce operating costs or to improve productivity through streamlining the processes comprising routine tasks, while effectiveness can be increased by using IT to foster greater flexibility and responsiveness to the changing market needs – such as having an effective web presence, being able to transact faster, being able to recover dues faster etc. Finally, each involves using IT to stretch and blur geographic boundaries for customer-access, and structure involves using IT to change the industry or market practices – a prime example of the cutting out of intermediaries in the travel industry due to the advent of travel portals can be cited here.



In the above matrix, companies in the lower left quadrant are labeled "unfocused" since they have no clear goals for IT or are indifferent towards IT. This 'don't-care' attitude often leads to a situation in which IT spend is viewed as an expense to be minimized rather than something of strategic importance and that needs to be managed. As a result, they adopt a wait and see attitude to technology investment, preferring to delay investment to the point beyond which there is no alternative. Such companies adopt technology only when they really have to –

perhaps to comply with industry standards, Government regulations or both. Failure to formulate clear goals for IT can lead to problems elsewhere. For example, such organizations are more than likely to mismanage their IT investments, leading to a vicious cycle that weans the potential for realizing benefits from IT investments. Put together, this has an impact on the economy as well.

In contrast, "operationally-focused" organizations (in the upper left quadrant) have clearly defined goals for IT centered on efficiency in operations. In such cases, IT is applied to reduce operating costs and to enhance the overall efficiency of business operations by focusing on the basic qualities like transactional quality, accuracy and speed. This is exemplified by Chevron (consulting provided by L&T Infotech). They wanted to improve exploration and production efficiency first. This involved deploying IT to reduce cycle times to find, drill and produce products. It also involved using IT to reduce costs and to increase exploration success rates. Then, they moved to improving the core internal processes relating to finance, human resources and procurement. This enabled them to gain greater control over their internal processes, as well as better respond to the environmental uncertainty and the emergence of new competition.

The third quadrant (bottom right) contains market-focused companies that use IT to enhance their strategic positioning. They typically use IT to create or enhance a value proposition for their customers. For example, companies today are using tools such as Business Intelligence (BI) to segment their customers, offer them targeted offerings, and gain insights into the operations of competition within the industry. Experience has shown that to be outward-looking, one has to have ones inside processes robust. Therefore, typically such firms have applied IT to a large extent to streamline their internal processes as well.

Lastly, an increasing number of organizations recognize the importance of both operational effectiveness as well as outreach. They further realize that IT can address both these functions simultaneously. Such organizations extend their use of IT beyond operational effectiveness to include market reach as well as the creation of new markets. Their goals for IT contain both top line (revenue growth) and bottom line (profitability) elements. There are a number of examples in today's context. Most of the executives of the "vanaspati company that was

looking to open an IT division" (Wipro Ltd. today) have gone on to become the CIOs in various other organizations – and it is precisely this dual-focus that these companies want from them – they rest their faith in the firm belief that IT is key to their current and future business success. Based on Porter's argument that organizations that favor strategic positioning over operational efficiency will achieve superior levels of performance, a corollary comes out that firms with more focused or strategic goals for IT will also realize higher levels of IT business value.

There are documented studies that have shown that perceptual measures of an organizations performance correlate strongly with objective measures. For example, in a study by Venkatraman & Ramanujam *(Venkataraman, 1987)*, 'C' level executives were asked to rate their organization's performance relative to that of their competitors using criteria like sales growth, net income growth and RoI. The survey found a high degree of correlation between their perceptions and the associated performance metrics. This led the authors to conclude that perceptual data from such executives can be used as an acceptable indicator of performance and productivity. Adding to this, these perceptions of returns from IT have also correlated with more traditional economic performance metrics such as revenue, net profit and productivity *(Tallon, 1998)*.

There are supporting hypotheses to this as well. For example, *(McLean, 1992)* argues that executives at that level are ideally positioned to act as reliable sources of information in a qualitative assessment of IT impact in their organization. He cites two reasons as the basis for this argument. First, as direct consumers of IT, these people can rely on personal experience when forming an overall perception of IT impacts *(Olson, 1985)*. Second, as these executives become more involved in IT investment decisions, they are increasingly exposed to the views of peers and subordinates regarding the performance of previous IT investments *(Watson, 1990)*. When combined, these arguments confirm that executives are an important source of information on IT impact, thereby supporting the use of executives' perceptions in evaluating IT's RoI.

The first set of studies in this area focuses on correlations between use of IT and extent of business change. An important finding is that IT investment is greater in organizations that are

decentralized and have a greater investment in human capital. In the new millennium, *(Bresnahan, 2000)* conducted a survey of large organizations to get data regarding their organization structures. It was found that greater levels of IT application in these companies were associated with increased collaboration between teams as well as increased skill levels in these teams. Additionally, they found out collaboration often leads to a complementary work system.

Further studies on specific jobs within certain industries have elaborated this relationship. For example, *(Autor, 2000)* has found that computers are most likely to substitute for tasks that rely on fixed-option, heuristic decisions. In the BFSI sector too, it has been found that many of the tangible benefits to business from the application of IT depend on the extent to which organizations club such initiatives with business process re-engineering and other complementing decisions *(Hughes 2000)*. This has also been found to be an important factor to measure the business's capacity to deploy IT effectively. A number of industry-level studies also demonstrate inherent linkages between IT investment and the increased skill levels of employees *(Rosenblum, 1992)* and *(Krueger, 1998)*. Again, these findings are consistent with the idea that increasing applications of IT are associated with a greater demand for human capital.

Several researchers have also examined the effect of IT on organizational forms and structures. They have typically found that greater levels of investment in IT are associated with smaller firm size and lesser vertical integration. Though this may not manifest itself in large conglomerates like IBM – whose size exceeds that of many economies? However, within IBM, there will be a number of virtual organizations that go into acting like a gestalt. Enhancing the level of IT investment in a sector – say manufacturing or services – has been correlated with a reduction in the average size of a company in that sector *(Brynjolfsson, 1994)*. These results corroborate case-based analysis done earlier as well as theoretical arguments that advocated that IT would be associated with a decrease in vertical integration since it lowers the cost of interaction with suppliers or distribution channels. *(Benjamin, 1987); (Row, 1992)*.

One difficulty in interpreting literature on the correlation between IT and business transformation is that some companies are early adopters – the first ones on the block – those that embrace every new idea and technology, whereas others are conservative and averse to

trying anything new at all. This tends to bring in pseudo conclusions since the adoption of these business complements may be the result of just experimenting with what is available instead of having any link with IT at all. To filter this element out, it is useful to examine metrics like productivity and economic performance as well. If combining IT and complements like BPR is legitimate, then companies that adopt all components should outperform those that adopt any subset. This is borne out by *(Hitt, 2000),* who shows that businesses that adopt both IT and business complements are on an average 5% more productive than others that have adopted only IT or a business complement. The same results are shown in these organization's stock valuation. Companies that had deployed both IT and business complements had a 6% higher market value. This further strengthens the hypothesis that IT effectiveness acts as an intangible asset for companies.

The above analysis demonstrates that a combination of IT investment coupled by changes in business and work practices contributes to business's productivity and market value.

1.7 Impact on Economy

While the above evidence clearly indicates that IT creates substantial value for organizations – if deployed correctly, the impact of this on the performance of the economy as a whole is difficult to assess. One of the important reasons for this is that the traditional methods of estimation focus on the quantifiable economic aspects of output – like price and quantity, while ignoring the added intangible benefits of new, customized products and services, improved quality, improved customer experience, and transactional accuracy and speed. These methods also focus on the observable aspects of IT investment, such as the (falling) prices of total purchased hardware, and ignore the much larger intangible investments in developing complementary new products, services, markets, business processes, and skills. An estimation of the actual spends on IT and business complements indicates large numbers – of the order of 10 to 1 *(Yang, 1997).* Thus, the $320 billion IT spend in 2004 for SMEs only in the US *(Forrester Research, 2005)* may actually be $3.2 trillion of IT-related complementary business assets.

Examination of individual IT projects based on a study by SAP Labs (2004) indicates that the 10:1 ratio may even be an underestimate in many cases. For example, in a survey of a currently

common mobile computing category projects, IDC (2006) found that the RoI was actually 459%—as shown in the Table 1.1

Table 1.1 - RoI of common mobile computing projects as per IDC

Item	Average per user
Three-year cost of investment	$4,950
Annual cost savings and increased revenue	$10,044
Net present value of three-year savings	$19,611
Payback period	7.5 months
ROI over three years	459%
Hard-costs-only ROI over three years	212%

Source: IDC, 2006

Another study conducted by SAP AG *(SAP AG 2004)* on Enterprise Resource Planning (ERP) systems in large organizations, found that the average spending on hardware and telecommunication costs accounted for less than 17% of the typical project cost, while software licenses costs were another 31% of total costs. The remaining costs included hiring consulting companies to help in the BPR exercise and training. The Hackett Group (2004) substantiates this – though they include the opportunity cost of the in-house implementation team as well in the total investment required.

Based on the above, we come back to the question of how these measurement problems affect economic growth and productivity calculations. In a steady state economy (where manmade capital and the population are fixed), it makes no difference, because the amount of new organizational investment in any given year is offset by the "depreciation" of such investments in the previous years thus making the net change in capital stock zero. In practice, however, the economy is not in a steady state in any respect. Nor are all expenses actually accounted for as investment. The Government has classified expenses on software as intangible capital and thus it can be shown as part of a company's Balance sheet. On the other hand, software forms

a small percentage of all types of IT spend. This brings us to the conclusion that it is difficult to estimate precisely the quantity of IT spend, it is indisputable that these complementary changes are numerous, have substantial spend and cannot be ignored in any realistic attempt to estimate the overall economic contributions of information technology.

Another factor that plays an important role is the failure to account for changes in product quality as well as the generation of a whole host of new services that are 'intangible' in nature yet contribute significantly both to revenue numbers as well as to spend. The dot-com bubble of the late 1990's exemplifies this model – wherein a whole slew of companies dealing in services came up as a mushroom growth. Some of those companies still exist today and are doing extremely well. Baazi.com that was taken over by the international giant Ebay is just one example. It is typically much easier to count the number of units of produced output than to estimate such intangibles – especially across geographies and customers. It is these intangibles, in fact that can sometimes generate investment – as can be seen from the numerous examples of call centers and business process outsourcing that have formed new industries in the world – including India. The motivating factors in this case are Quality of services, convenience, and timeliness – all linked to substantial cost savings achieved through differential cost models.

Some very interesting facts (or their interpretation) can be seen from government data – especially in sectors where output is difficult to measure and where changes in quality are especially important *(Griliches, 1994)*. This is illustrated by selected industry-level productivity growth data over different time horizons, shown in the table 1.2 below. According to these estimates, a bank today is only about 80% as productive as a bank in 1977; a health care facility is only 70% as productive and a stock broker only 65% as productive as they were 1977.

Table 1.2 - Annual (Measured) Productivity Growth for select Industries

Industry	*1948-1967*	*1967-1977*	*1977-1996*
BFSI	.03%	.21%	(-)1.19%
Healthcare	.99%	.04% (-	(-)1.81%
Financial services	.23%	)2.01%	(-)2.13%

Such figures are hard to believe. In 1977, virtually all banking was conducted physically by visiting the bank's branch. Today, customers can access a network of hundreds of thousands of ATMs (automated teller machines) 24x7 *(Osterberg and Sterk, 1997)*, as well as funds transfers, cheque book requests and other banking services via the Internet. Computer aided medical equipment has enabled more accuracy in operations, a higher success rate and less invasive medical treatment. Many procedures that previously required extensive hospital stays can now be performed on an outpatient basis. Instead of surgical procedures, many ailments are possible to treat using non-invasive lasers, high frequency sound, or diathermy. Imaging devices such as x-rays, MRI, or CT scanners have dramatically improved the visibility into the human body. IT has supported the research and analysis that has led to these advances plus enabled facilities like telemedicine wherein a practitioner can provide treatment off-site through online means. A stock broker or financial analyst today can access a much wider range of information through global on-line databases as well as have real-time access to stock market data.