

IMPACT OF INFORMATION TECHNOLOGY ON ORGANIZATION PRODUCTIVITY: ROLE OF ERP**Nadia Movahed^{1*}, Sepehr Saber²**¹Department of Industrial Engineering, Amirkabir University of Technology, Tehran, Iran.²Department of Quality Technology and Management, Tehran, Iran.

*(corresponding Author: Nadia Movahed)

ABSTRACT

Numerous studies have been conducted on the effect and the degree of contributions by organization's variables on productivity based on which learned that one of the main factors affecting the productivity of an organization is the way the job is being done. The increasing growth of information technology, especially software industry, is developing the majority of fundamental elements in systems and methods of work. In recent years, there have been considerable investments in equipping the organizations with advanced information technology facilities like computer hardware, technical and managerial software, development of internal networks and connection to global networks. This matter has facilitated the access of organizations to more effective inputs, which could lead to outputs of better quality in bigger quantity, hence improvement in productivity. Nowadays we are dealing with variety of information technology related systems where each, as a powerful tool for management, is focused on specific part of business and organizational processes. Implementing Enterprise Resource Planning, as a facilitating tool, not only strengthens the organizational structure and operational processes, also improves the social, cultural and economic contexts in organizations. Therefore, addressing the role of this tool in eliminating non-value added activities, improvement of efficiency and productivity of the organization is of great importance.

KEYWORDS: Enterprise Resource Planning (ERP), Information Technology (IT), Integrated Information Systems, Productivity, Systems.

INTRODUCTION

Productivity is a fundamental and important criterion within the economy and is referred to as an index of wealth and assets of a country as well as its level of development or lag. It can be expressed as a tool to measure life standard. Now a day, in the era of globalization, high national productivity is the required condition to be able to play an active role within the global arena and is fulfilled through higher production output along with constant or even lower input.

Entering the 21st century, appearance of new economy has become obvious and according to the theory raised by Toffler (1990) and Kuhn (2012), a paradigm transformation is performed in every rotation, and the new paradigm would bring up its own specific theorization, economy, life style and technologies. Therefore it is clear that we should also look for better theories, architecture and new configurations within the organizational field. Drucker (2001) points out that informed activity toward labors' productivity (who use their body strength to do their job) improvement in the 20st century could increase productivity with an order of 50 times. The same task may be done in terms of science related jobs and educated or knowledge workers in the 21st century. Educated workers are those who use technology, and particularly information technology (IT), to do their jobs. In recent years, organizations have invested highest levels of funds on IT, such that according to some evaluations, more than 30% of all investments around the globe have been spent on the information technology industries during 1997 – 1987. This trend has continued along and in 2004, 484 billion dollars equal to 40% of total investments by corporation in the US, has been dedicated to data processing and software development sectors (Jorgenson *et al.*, 2002).

Working style and effectiveness of the information technology along with heavy investment within the organizations have also evolved through the time. Personal computers do the tasks much faster than old mainframe computers. Information systems are gridded through organizations and allowed users to share their thoughts, plans, files and electronic messages. Accessing to internet has pushed the field of accessing and sharing data within the organization far beyond geographic borders. So, new processes, organization procedures and collaboration ways as well as activities through working groups and development of new sciences and skills are often influenced by development of information technology in organizations. Therefore, there is a natural need to change productivity measurement and improvement techniques as well.

Numerous studies have been done on productivity concept over its economic, industrial, organizational and information technology components reporting relatively contradictory results. Productivity paradox is the term generated after these series of studies. It means that development of information technology have improved the productivity of some organizations in a tremendous way while no significant influence is evident for others (Brynjolfsson *et al.*, 1998). Having entered into the information economy space and considering inevitable investment of organizations on information technology, regardless of limitations in financial resources specially in developing countries, presenting a clear picture of the relation between IT and productivity and looking for means to maximize the productivity are of high priority in organizational researches on IT investment. Hence the presented research has investigated this subject and suggested a model for improving organizational productivity through the attention to resource planning systems by information technology along with personal and organizational performance enhancement in information processing.

MATERIALS AND METHODS

According to Drucker (2001), competitive strength of the corporation in market, and its innovation strength, cash flow status and profitability as a part of reliable factors to be used as measurement criteria for economic firms in the third millennium of business, each of which poses the highest connotation on the productivity. Now a day, in order to achieve a comprehensive picture of companies' performance, you may pay attention to a balanced complex of criteria and indices to be able to establish a reasonable, rational and proper balance and equivalence about corporations' performance. Sink *et al.* (1982) believe in one other classification in which measurement indices may involve factors like: effectiveness, productivity, quality, innovation and profitability.

Kaplan *et al.*, (1996) believe that in the information era, organizations need to achieve new abilities like the ability to communicate with customers, production innovations, ability to present customer order based products, personnel skills, motivation and technological skills in order to achieve a success in the competition. Mentioned notes confirm this fact that the organizations have to meet new productivity standards, or in a better word, have to redefine the productivity in accordance with modern realities in the business sector.

Productivity, a main criterion for measurement and leadership of the organization's performance

Productivity is a complex topic which includes many factors. There is even no general consensus on the definition of productivity. Different definitions are proposed by expertise and international organizations such as International Labor Organization, European Productivity Agency, Asian Productivity Organization and National Iranian Productivity Organization. It seems that the most applicable definition is the one proposed by NIPO which is "to maximize implication of resources, manpower, facilities etc. in a knowledgeable way, reduction of production costs, expansion of markets, and to try to increase real wages and improve life standards in a way to be advantageous for the workers, management and society."

According to the conventional definition, productivity is equal to the ratio of the value obtained from the results to the value of used resources. It is clear that if the numerator of the fraction increases or the denominator decreases, the productivity will go higher. Therefore before doing any analysis, we should evaluate the value of the numerator components or "implemented resources" as well as the value of the denominator components or simply "obtained results". In order to achieve maximum productivity, we should first study the agents and components of the numerator and then continue to investigate the causes and components of the denominator and finally focus on their relationship with productivity. Of course while investigating effects of different causes on productivity in terms of inputs and outputs; we should also pay attention to the organizational environment affecting the productivity so that productivity causes can be reasonably and completely investigated.

Information and communication technology (ICT) role and revolution

Investigations reveal that in 1965, information and communication technologies had constituted about 5% of corporation investments: this percentage has increased to 15% by the 1980s, and in early 1990, information technology investment by the corporations reached to 20% of the corporations' costs while this percentage was observed to be 50% of total investment costs of corporations by the end of 1990s (Doms, 2004). Indeed, a very important evolution called "information and communication technologies (ICT)" has happened in the economy arena which formed the basis for modern economy and has a strong influence on U.S. and some other countries economic growth. Therefore, this technology has changed business fundamentals and can be a strategic favor for the companies. According to the results

presented in development and trading conference (UN, 2003), there are two approaches toward the information technology in the developed countries. Some countries look at IT in production sector while some others follow it as a driving for other sectors.

However, there is still no clear answer to the question of how much information and communication technologies are required in economic development of the world's countries. Once upon a time, industrial countries were not yet developed and their passage through different stages of development has definitely not accomplished by programs and contributions of information and communication technologies. Some researchers stepped even farther and believe that information and communication technologies have not played an important role in productivity enhancement within industrial countries. Solow (1957) was the first who stressed such contradictory reasoning. He claimed that computer growth everywhere can be seen, but productivity data does not show such a growth. These contradictions are justified in several ways, one of which being the fact that since the developed economics are those that work in effective conditions, introduction of information and communication technologies in such economies can only have a marginal effect: that is, although the introduction of each producing and servicing unit of information and communication technologies may contribute to GDP (Gross domestic product) of these countries, but these effects will not be significantly increasing.

Preliminary studies at macro levels in which data from late 1980s and early 1990s are used, have come to this conclusion that contribution of information technology to productivity and economic growth have been very low. The explanation for this finding claims that information technology investment with respect to total economic investment, was less than enough to have fundamental influences in economic productivity. For example, during 1990s, mean annual rate of investment on information and communication technologies in the United States increased from 17% during 1959-1995 to about 32% during short period of 1995-1999 as the computer prices accelerate to fall down. It is clear that decreasing prices of information and communication technologies has led to encourage organizations to replace working labor and other forms of assets like factories, machineries or equipment with information and communication technologies. This has an impact on working labor productivity and economic growth in macro level. U.S. working labor productivity which has experienced an annual increase of 1.5% during 1973 – 1996, faced an enhancement and reached to an annual amount of 3.1% during 1995 – 2000 (McKinsey, 2002). In most of macroeconomic studies, this acceleration in recent productivity values and economic growth is referred to the meaningful and important effect of information and communication investments.

This new era is characterized by two components: 1) globalization which works toward the deregulation, integration of global markets in terms of products, working labor and investment and increasing competition; and 2) technology revolution based on information and communication technologies in every aspect which results in increasing economic growth and productivity. Modern economy in recent definitions is defined as an economy that has a high growth of production and productivity by producing and using information and communication technologies' products. A lot of economists, managers and industrial and IT engineers who are educating in the field of productivity, recognize information and communication technologies as the main core of current technical evolutions and try to quantify their influences as technology flow is effective in different economic processes, such that these technologies aside with production agents may lead to cost reduction and productivity increase in manufacturing and finally to enhance economic growth in the developed countries which is observed, although with a lag time, in some developing countries as well. Technological changes play an important role in economic growth. Technological changes are associated with evolution of production techniques which is powered by innovation and application of modern production and resource allocation methods. Technological changes cause an improvement in productivity of the work, investment return and other production factors.

Baily *et al.* (2001) believed that an economic innovation both in production and in application of ICT has experienced since 1995 which leads to an improvement in U.S. economy and particularly has accelerated productivity performance of entire production factors. They believe that major impact of ICT has influenced public service sector like financial and trading subsectors. Similar researches also showed that investment on ICT is an alternative for working labor: because implication of ICT will allow the corporations to reduce the number of workers present in the corporation or to increase the output faster. Therefore, organization, as a social system affecting national productivity, may help managers and officials in charge to make the organization more effective in terms of harmony and continuous

accountability to the related external environment. Development of information and communication technologies in developed countries has led to increased productivity of their economy and the promotion policy of information and communication technologies in these countries which has resulted in improved organizations' performances, appearance of new markets and enhancement of macro and micro economic variables since 1990s (Oliner *et al.*, 2002). Therefore, potential of ICT to accelerate economic development and upgrade life standards and on the other hand, international communities insisting on the importance of better access to mentioned technologies (especially in developing countries) are considerable. Accessing to and developing ICT, computers, digital networks, telecommunications, TV etc. have led to form an unprecedented capacity to promote knowledge and information. Although the impact of information era is sensible in terms of education, research, medical affairs, government, business and leisure in many parts of the world, just 5% of the world's population are enjoying its benefits (Doms, 2004).

Table (1) shows the number of ICT-related tools and facilities per 1000 of population through different groups of countries in 2005. In order to be able to compare different countries, income-based and geographical-based classifications of countries are adopted in this table. Considered tools and facilities include TV, telephone, cell phone and internet users.

Table (1). Volumetric enjoyment of population of different regions of the world from ICT-related facilities (WITSA, 2006)

Different regions	TV	Telephone	Cell phone	Internet users
East Asia	800	188	243	74
Europe and central Asia	920	79	457	138
European Union	970	526	457	443
Poor countries	130	5	41	13
Rich countries	980	537	772	545
Latin America	880	180	319	115
Developing countries	110	9	28	8
Low income countries	150	30	41	24
Middle East	880	90	129	58
Middle income countries	890	190	292	91
Southern Asia	320	35	41	26
Africa	150	10	74	19
Entire World	840	192	279	140

This table indicates that the oldest tools have experienced the highest levels of extension. Two major causes could be expressed: firstly, people noticed the advantages of technology as the time pass and they feel a need to them. The second is that production technology of these tools has developed throughout the time, production volumes have increased and therefore the prices are lowered. Hence more groups of people get chance to use these facilities. There are numerous evidences related to the positive effect of ICT on the economic growth and productivity all kinds of countries. To move further, although much is known about the general effect of information technology on productivity, there is less understanding of the value of specific IT applications and the factors that make a particular project or system more effective (Hitt *et al.*, 2002). Enterprise Resource Planning (ERP) software system as an influential software system introduced in evolution of information technology, integrate key business and management processes within and beyond a firm's boundary to optimize productivity by focusing on better planning and allocation of resources.

Resource planning in the organization

Historical speaking, resource planning in business environments goes back to 70s when Material Requirements Planning (MRP) was first presented by Orlicky (1975). This system mainly looks to the material planning based on Bill of Materials (BOM), Mass Production Schedule (MPS), abilities and working capacity. It was 1984 that Wight (1995) presented the subject of Manufacturing Resource Planning (MRP II) in which the focus is on entire machinery

resources, materials and manpower. Tasks like corporation planning, production planning, main schedule of the production, material requirements planning, and executive system requirement planning for capacity management and priorities were all dealt with in the resource planning. With finished price and competition in the business world uptake in 90s, Manufacturing Resource Planning (MRP III) was introduced which stressed out the subject of financial management of production manufacturing. Parameters like financial plan of the firm, purchase committee, budget and inventory were also taken into account. With this approach a new term called ERP, Enterprise Resource Planning, promoted. MRP system dealt with inventory while it children MRP II and MRP III moved further and considered production planning and accounting issues as well, and now ERP which is a descendent of MRP, covers entire extend of the firm's systems from supply chain to customer support. Manufacturing firms were traditionally operating in two distinctive systems including design and non-design activities respectively.

Enterprise Resource Planning (ERP)

Richardson (2010) a clear-sighted in management sciences, defines ERP as “a software suit consisting several firm applications which are used to supervise and control over key tasks of a firm within an organization, corporation or agency. In other words, ERP is a link between financial software packages such as ledger, purchases, payroll and others in terms of operational aspects such as engineering, production, research and development (R&D) and manpower that supports the operation”. ERP serves many industries and numerous functional areas in an integrated fashion, attempting to automate operations from supply chain management, inventory control, manufacturing scheduling and production, sales support, customer relationship management, financial and cost accounting, human resources, and almost any other data-oriented management process. ERP systems have become increasingly prevalent over the last 10 years (O’Leary, 2000)

It is important also to note that currently there is no much difference between MRP II and ERP through the academic and industrial communities, except that MRP II is used for production corporation and factories, while ERP may be used for any kind of organization and it seems that even in factories and production corporations, they are gradually shifting from MRP II toward using ERP. Considered resources in ERP include manpower, money, machines, materials and data. ERP introduce itself as the proctor of the entire intra-organizational information and tends to carefully manage and process them in detail. ERP’s productions or outputs are different types of managerial reports and the required information for managers to take decisions about longtime planning, determination of the organization strategies and so on. Therefore, ERP implement integrated management of entire resources required for operation of an organization, establishment of required inter-department and intra-organizational connection and mitigation of waste connections (activities without added value) which finally lead to an increase in productivity of each department as well as entire organization.

RESULTS AND DISCUSSION

As can be seen in literatures, productivity of the organization resources, and the therefore the overall productivity index, is directly influenced by implementation of information technology. That is the more ICT implemented principled in every corner of the organization, the more it can improve productivity. This trend continues to a point where the company is saturated with respect to IT implementation. The more this implementation performs with a better planning, balanced and considering the results of “benefit analysis and cost” and also following the priorities, the more improved productivity of total organization resources, consequently productivity index, will be achieved rather than the situation where these constraint are less considered.

It is of importance to contemplate irreversibility in design of the organization resources productivity growth process. Positive activities growth is not necessarily irreversible and durable. When an improvement is achieved, there is a need for some proper basis so that what is “improved”, transforms to something “developed”. That is to say, positive trend gets institutionalized and becomes irreversible to later conditions. This is when it can be claimed that the development is established. Of course this does not mean that we should always look for an irreversible growth and look at the other improvements as unacceptable or rejected. In some cases, periodic requirements or available resources necessitate us to make an improvement in a specific field, even if it is temporary and not durable. But in most cases, the effectiveness of the improvements we make is laid in their durability. Realization of durability in modifying trends is much more expensive than sectional and temporary modification processes; but the value of modification comes from durability of improvements and stability of good things made.

Therefore, one main reason in benefit of ICT implementation relies on irreversibility and persistent of development brought along its implementation. Hence, when planning an organization functional system and its resource management forms on the basis of this technology, how can one imagine that once the organization survived, planning and management systems established based on this technology, may reverse to previous status. When trading communications and customer relation management is based on ICT, it is not possible to shift the organization back to the previous state. Even in the simplest and the least important fields in which IT replaces human elements or manual approach of work, providing this replacement performed properly and principally, neither organization reversed to the previous status nor there will be any determination among managers to do so.

From this perspective, application of standardized systems and procedures in organizational structure of operations makes it possible to have a systematic approach toward each person role via which one can improve organizational functions. Once this procedure is localized in and spreads over the organization, all group members and implementers of this approach work together to mitigate losses associated in wrong investment, personnel malfunction, materials defect and time loss which may result in better position in the market.

Eventually, based on this approach, daily jobs will proceed faster, less costly, simpler and safer. Since implementation of ERP is inherently associated with some type of pathology and understanding of current situation, when we go in the path of processes' improvements, root causes of destructive phenomena happened during installation of system and corresponding processes can be detected systematically which may result in possibility of suppressing their negative effects, modify some activities in an attempt to reduce errors and enhance the operation. Therefore, some advantages of implementing of ERP, as an example of IT based tools, can be addressed as below:

1. Cost saving and improvement in exchange of information.
2. Avoid human mistakes when dealing with very complex reparative tasks.
3. Financial saving due to error reduction and lowering time duration of tasks completion.
4. Integration of several tasks.
5. Improvement of productivity (efficiency and effectiveness) in every process and related procedures.
6. Enhanced middle management and reduce waste processes via structured information fellow.
7. Generating centralization while decentralizing organization management.
8. Mitigation of geographical borders among organizations' offices.
9. Promotion of cooperation culture among personnel.
10. Controlling service delivery efficiently and managing increase of customer satisfaction.
11. Enhancing competition of the organization in domestic and foreign markets.
12. Reducing hierarchy and height of management pyramid in organizations.
13. Mitigation of parallel sub-organizations and clarification of tasks towards optimized integration
14. Development and expansion of new business opportunities within organization.

CONCLUSION

The impact of IT implementation on organizations' productivity has been investigated in numerous studies out of which different, and sometimes contradictory, results are obtained. IT-productivity paradox reflects the results of such investigations. Studies have indicated that IT have succeeded to increase the productivity in some organizations, but failed to be productive in others. In other words, investment on IT has led to an increase in productivity when its development is accompanied with other necessary changes in the structure of organizations. Now a day, organizations are referred to as social systems and some address human societies as the society of organizations; a society full of evolutions and alterations with their roots in the scientific and technological advancements. Presence of such fast evolutions within the environment indicates that it is not possible to achieve effective management and optimal organizational productivity by solely relying on personal experiences.

In such environment, applicable solutions and techniques, which can secure innovation and cost efficiently provision of quality products and services, are required to ensure the survival of an organization in a competitive market. Improvements in working methods of each personnel daily job by benefiting from IT based standardize solutions will result in cost efficient, better quality outcomes in the minimum possible time. Among those, utilizing Enterprise Resource Planning (ERP) as an improved effective solution will bring many benefits for the organization through

systematic resource planning and allocation which lead to increase in efficiency and improvement of effectiveness (growth of productivity) in every operation in the whole system of the organization.

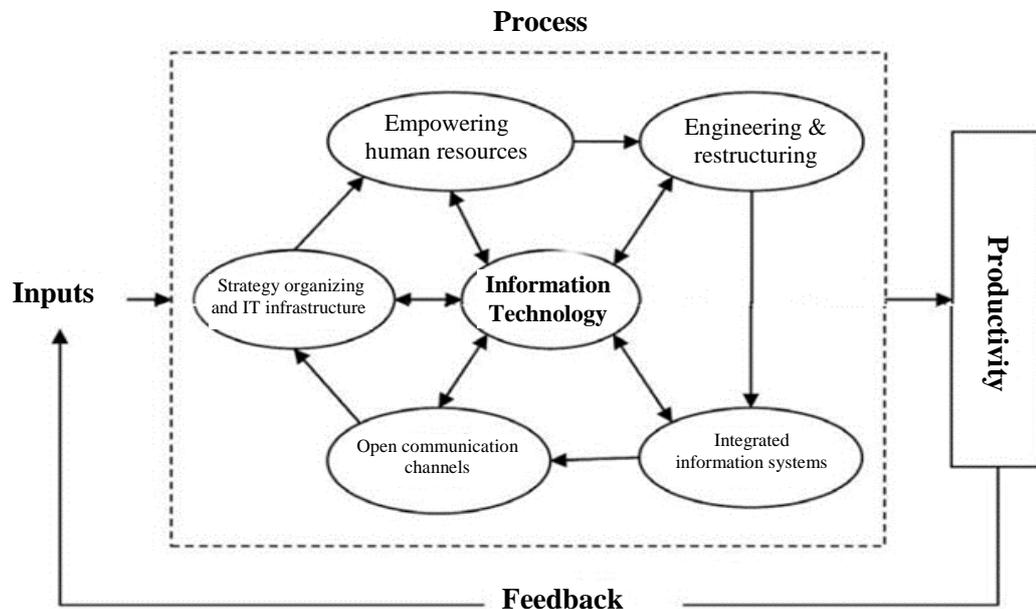


Figure (1). Proposed model for enhancement of organizations' productivity with emphasize on the role of IT.

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