

## METHODS FOR ASSESSING THE INFORMATION TECHNOLOGIES AND COMMUNICATION IMPACT ON COMPANIES

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#### Abstract:

*The determination, identification and evaluation of the impact of Information Technologies and Communication use in companies are complex issues that require quantitative and qualitative approaches that take into account one or at most two parameters. Most of the empirical studies focused on the impact of Information Technologies and Communication on the economy are statistical approaches that take in consideration only one performance criteria of the company, such as Information Technologies impact on productivity or the impact of Information Technologies on investments. The impact study approach can have an a priori and a posteriori perspective. Before the introduction of Information Technologies it is necessary to make some predictions or estimates. After the introduction of Information Technologies, the actual assessment takes into account the effects. The research proposes a methodology for assessing the impact of Information Technologies taking in consideration a priori and a posteriori aspects. Also, it is developed a metrics for the evaluation the quantitative impact assessment such as Information Technologies endowment of labor, and efficiency of funds invested in Information Technologies. The methodology consists by an algorithm that can be implemented in companies. The calculating the proposed indicators help quantify the effect of applying Information Technologies and establishing their effectiveness.*

**Key words:** Information Technologies, companies, impact assessment, metrics

#### INTRODUCTION

Although more than 25 years have passed since Solow (1987) introduced the concept of computer productivity paradox in economics, his observation of concerning the slow productivity growth remained valid despite the revolution in the field of Information and

Communication Technology (ICT). Nevertheless, over the last years, productivity in the United States has significantly improved, and the perception on the Information Technology (IT) has reversed, being seen by many as the renewal driving force of the productivity increase in the United States following 1995. The global growth studies show significant contributions on the productivity both from the IT production industries and the industries using IT, while the comparisons at industry level show that IT intensive industries enjoyed the largest productivity after 1995 (Baily, 2002). Similarly, the function of production estimated using data from companies or industries show a significant relation between IT and productivity, case studies documenting the major benefit of IT in various industries such as transport and health. Marquez and Ovalle (2001) assess the possible impact of the new communication technologies on the performance of a generic supply chain. A simulation study has been accomplished in order to conceptualize the integration process that could take place in the v, and to measure the supply chain flexibility improvements as a consequence of a faster and shared information flow. These results show orders of magnitude of the improvements in terms of operational and financial metrics.

Gordon (2000), Jorgenson and Stiroh (2000), Oliner and Sichel (2000), Schreyer (2001), Spiezia (2011) and Strauss etc. (2011) have exemplified through empirical studies the ICT impact on various branches of the economy and society. Stiroh (2002) has published a study, a meta-analysis regarding the evaluation of the information technology role in fulfilling the function of production. The shown estimates do not reject the optimistic approach, but the meta-analysis outcomes and new econometric methods suggest circumspection when attempting to accurately quantify the IT impact. Differences among the econometric methods have led to the development of a wide range of estimates of the output elasticity for IT, which have very different implications for the IT importance to the economy, in the case analyzed by Stiroh (2002), the USA economy.

Estimating the production functions by levels is the most common technique presented in the specialized literature and virtually all level evaluations from the USA data highlight a high elasticity for IT. This involves either returns in excess for IT or leave out the consideration of certain outstanding variables. Construing the omitted variables seems the most sensitive issue, insomuch as increasing the volumes of scientific works within the area of microeconomics emphasises the importance of complementary innovations, such as the practice improvement at the workplace and redesign ( re-engineering ) of the company for the successful implementation of IT. A pessimistic approach is that the IT introduction does not really matter, and have been simply assigned productivity growths that are owed to other factors. This approach seems too radical, as all capital coefficients tend to be lower in these specifications, and it is unlikely that the entire capital be really unproductive.

The reported outcomes suggest that researchers have a high discretion in judging the types of evaluations that they report. In case the researchers are more inclined to report only those evaluations according to the expectations, then the published literature will over use the Ordinary Least Squares (OLS) on the levels providing these outcomes. Research on productivity focuses on regression appraisals by levels, without paying a particular attention to the heterogeneity and simultaneity problems. The conclusion of this research is that the IT introduction influences the productivity evolution, but there have to be reservations towards the results of evaluating the influence size. Stiroh (2001) asserts that the use of IT has played a critical role in the U.S. productivity revival. Europe has the experience of the influences of a less spectacular but non-unitary entering of IT in economy. There are discrepancies between

investments and ICT use between the Netherlands and Ireland relating to France, Germany and Italy and, therefore, different from the USA. IT accompanied by complementary innovations, provides solutions for sustainable growth. The IT considered input behaves as the General Purpose Technology (GPT), obviously maintained by a high elastic demand for semi-conductors/microprocessors, and generate spillovers effects or what can be called carrying away effects in the economic sectors that have invested in IT and developed complementary innovations for benefitting from all the advantages offered by IT (Basu, 2003). Thus, the IT enters into a logic of endogenous-exogenous productivity.

As regards USA, it is considered that the Solow paradox has been exceeded. Great Britain has experienced a boom in the ICT investments in the second half of the 90's, but the growth rate of Total Factor Productivity (TFP) has decreased. If investments in ICT in the UK are associated with a low TFP, it is because more resources are allocated to the reorganization and learning than than the output production. In USA and UK situation has been found to be a strong correlation between the use of IT in economic activities and TFP increase. The TFP increase is positively correlated with the ICT use, and negatively related to the boom in ICT investment. The common opinion on the USA economic boom in the second half of the 90s, is that ICT has fundamentally contributed to economic growth. It is considered that the huge investments, stimulated especially by the decline of prices, enabled the substitution by the IT capital of capital and labor. Thus, the IT entering in the economic activity explains the labor productivity increase.

The specialized literature approaches the mainly statistical impact of information technology. The research presented in this paper focuses on the non-statistical approach of studying the ICT impact by establishing an evaluating methodology of the impact, both *a priori* and *a posteriori* and proposes the introduction of new metrics and key indicators of performance for evaluation.

## **THE NEGATIVE IMPACT OF THE INFORMATION TEHNOLOGIES IN COMPANIES**

The introduction of technologies may sometimes have a negative impact on companies and business. The question is whether the IT decisions build or ruin a business. According to Thurnher (2007), the use of mobile technologies for IT management and improvement of business processes is far behind expectations, still little research has been done in analyzing critical success factors for mobile technology acceptance and usage when replacing a former paper-based process within the IT-Service area. Performingng an analysis from this perspective, we can say that within the business operation and functions, the ICT group holds a disproportionate control over what is happening or could happen in a company. The most visible is the control on the software instruments which are operated in the company. Starting with the browsers for Internet and ending with the information applications systems, the employees of most companies are not allowed to choose their own IT tools according to their wishes. Some companies allow downloading the minor software but in no way the major business solutions. When the IT group has chosen the basic computer tools, it automatically decides what employees are allowed to do.

Nevertheless, despite all significant benefits brought by the information technology in a company, there is the risk of IT governance which may become the opponent of what is really wanted. This is actually the power had by IT within a company. The company executive

knows this and most of the time it constitutes a considerable factor of frustration. Moreover, is the IT group evolving as fast as the business? Ideally yes, but in reality the IT demand is often larger than the capacity had by IT in the company, which may lead to a comstriction. If there is a perception that a request made to the IT will never be achieved or will be achieved in due time, then we can say that the IT limits the favorable possibility of a quality culture.

It is already known that IT decisions have long-term implications. In addition to positive implications, there are also negative implications. For example, choosing an ERP architecture that involves decisions concerning data storage and sharing. This may have deep implications on the stakeholders' ability to make decisions in due time. In many cases, especially in the current context, these IT decisions can build or take down your business.

Smart organizations favour the culture they want. They deliberately make decisions that encourage or discourage certain behaviors. In today's world, the brand and business culture are often interconnected and these are the ones guaranteeing the actual gain of the company on the market. Therefore, the relations between organizational culture and IT decisions to be taken, have to be very well understood. On the other hand, the lack of IT expertise can block small businesses. Recent studies prove that strategic use of IT in small businesses is the biggest challenge for their growth. CDW Corporation in the U.S.A. has monitored 152 businesses in progress or managers who have been successful in turning the business from a small one into a medium business, with 100 employees or more. In the study, 38% of respondents said that the IT management in their favor was a significant advantage ( McGillicuddy, 2007). 74% of small businesses' proprietors said they were totally involved in IT decisions throughout the entire period of their companies' development. Only 14 % responded that they considered there is enough IT for their employees to solve their work duties, and 5% answered they were conservative and only spend their money on a proven and profitable technology. In agreement with these proprietors, an aggressive IT strategy is translated into a strong development. Actually, 61% of the respondents who saw the IT as a strategic or competitive advantage had a 2-digit growth in the last 5 years. Only 43% of these companies have invested in IT so as to ensure that their employees have the same productivity increase. Small companies have rarely specialized staff for IT implementation. Only 24% of the individuals interviewed replied that they had staff members dedicated to IT. The others use IT following their own knowledge, outsource the IT , or use it with non-IT staff.

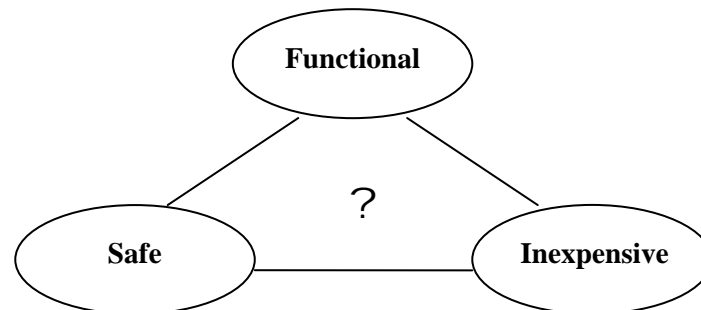
Beside the organizational aspect of the negative impact of information technology there is another impact, still negative, as regards data security. This is shown by loosening data confidentiality, through the phenomenon of "fishing" and virus infection. There are obviously certain ways of protection, but phenomena once occurred may cause significant losses to the companies.

## **THE QUANTITATIVE ASPECT IN IMPACT EVALUATION**

The impact is analyzed as an answer, an effect, a reaction of the environment, system, society, to certain stimuli, events, actions. The impact may be presented in qualitative, quantitative (numeric, percentage of increase or decrease, etc..) or mixed (qualitative and quantitative). The impact appraisal involves two levels of approach, ie conceptual level and overall level. At the conceptual level, which is the level of management knowing the impact is necessary for decision makers who, knowing the effects can identify

and treat the causes. At the general level, which can be identified with a factual level, the impact analysis is useful for the members of society, who actually bear the consequences, meaning the impact. Through the very nature of this notion, the impact approaches imply an *a posteriori* analysis, from the observed effect to causes, which in terms of the reasoning from the artificial intelligence is called, *backward chaining*. This manner is applicable to both macroeconomic and microeconomic levels and assumes the existence and statistical analysis of data for a certain period of time. There may be also an *a priori* approach, which is forecasting and useful particularly for company managers in order to know the trends and anticipate the effects, consequences.

The effects of IT entering in a business are evaluated through efficiency, productivity, business development and low costs. Since IT is one of the most dynamic areas, the technologies with more than five years being already obsolete, for withstanding the competition, a company has to keep up with the renewal pace of technologies, which is reflected in business efficiency. Increasing the labor productivity is one of the tasks of the managers, who must ensure that the employee produces more than the employer's total costs generated by its remuneration. Concerning the role of introducing IT in companies, many companies make investments because it is vogueish. Business development requires *inter alia*, online presence, new IT equipment and unique offers. The cost, along with functionality and safety, has a major effect on the beneficiary's purchase decision. An expensive product is not always a good product and a cheap product does not always bring cost savings. The main requirements of the beneficiaries for information technologies are plotted in Figure 1.



**Fig. 1.** Requirements for information technologies

Experience shows that the three conditions are contradictory and can be simultaneously met only by two of them. At this moment, it is not purchased a computer system that is safe and cheap, but not functional. Very rarely is purchased a safe and functional system, if expensive. Most choices are for a functional and inexpensive system, safety being left on the second place when making the purchase decision.

The study of quantitative aspects of measuring the impact of investments for information technology raise a number of problems, which are based on the following causes:

- there are no reference systems towards which to be assessed new improvements;
- the planning process of the IT installations or upgrades, may itself constitute an increase in efficiency, even without implementing a new IT system;

- the new technologies introduced in companies may put in difficulty the staff, who may have problems of adaptation, so that the new organizing in the company generated by their introduction to have initially have a negative impact on the activity efficiency in the company in the first months after implementation, so that an appraisal performed too quickly may have a false negative result and actually reflects the negative effects that may diminish or disappear over time;

- sometimes is not used the whole potential of the new technologies, situation met when it is not made an adequate training of the staff or when cultural or organizational barriers, which generate the conservation of an anti-technology mood, this causing long-term reductions in the effectiveness and impact.

Establishing the proper connection between the improvements occurred in the companies' business and causes that generated them is a challenge. At the same time, we identified the point where technology has no impact and the external factors, that have an important influence.

An innovative methodology that can capture all aspects of the impact of introducing IT in companies has to begin by applying the theory of change. An essential component of evaluating the IT impact is to understand the staff expectations to changes that the new technology will cause in labour and production. Expectations towards the information technologies, why and for whom will be produced the changes are questions that have been asked and answered by a group of key persons, including staff, end users, management board and financing persons. Also, there must be a clear understanding of the internal capacity limits: the staff may be able to receive many requests from customers, or customers relate more efficient to other resources, but this does not automatically mean that they will be better served. An important role is played by the basic training in information technology of key persons who should have at least working knowledge on the prerequisites and limitations of the information technology. Perhaps the most important key to the success of efforts to introduce new technologies is that organizations need to have an adequate training for using the new tools they possess. The efforts made to introduce IT in a company should be planned and carefully evaluated over time, while taking into account the effects on the organization, staff and services. IT is part of a broader context, namely of organizational capacity and culture.

## **TECHNIQUES FOR MEASURING THE IMPACT OF INFORMATION TECHNOLOGY ON BUSINESS**

For measuring the IT impact in business one needs to establish the most important performance indicators, called key indicators that will constitute the metrics for evaluating the IT impact. The key indicators will evaluate IT performance in the business performance. Thurnher (2007) has a major contribution in the identification of business metrics which are influenced by the mobile tool integration into mobile business processes.

The difference among the key indicators of performance is presented as follows:

- Performance indicators reflect the organizational goals;
- Performance indicators are established by companies managers;
- Performance indicators take account of the context in which the evaluation is performed;

- Performance indicators are based on legitimate data;
- Performance indicators are easy to understand;
- Performance indicators lead to action.

Key performance indicators influence, by their very nature, the actions. If a metric is not able to influence the behavior of the management team in a way that can be understood clearly in all departments, when it is a key performance indicator. Establishing the metrics and, consequently, the performance indicators, is the first step in passing through a program that implements the key indicators. The programs implementation starts by concentrating the effect on consensus, in order to be then iteratively developed. Because businesses are dynamic, refining the capacities of evaluating of performance indicators is more important than the actual measurement. Specialized literature reveals that, although there are different methodologies, most are based on a sequence of steps.

The algorithm resulted from research, which complements the existing methodologies, involves the following steps:

**Step 1.** Setting up a board for approving the key performance indicators

Performance indicators like all metrics, have low values in isolation. The best way to make sure that the system of indicators will be successful in measuring and influencing performance in companies is to reflect as early as possible the impact variations in acceptance of all stakeholders. In this regard, it is set up an Approval Board made up of key players of each department in the company. The Board of Approval is responsible for: validating/updating the performance indicators, monitoring data collection, analysis of results and transmission of results. It shall also contribute to maintaining the implementation process within correct limits, avoiding the intentional or unintentional hazard. The Board shall meet regularly and in sessions separate from those who have as agenda the budget or the company's structure and stay focused on the issues of the process and organizational performance. Having regard to the human dynamics involved in the assembly of an approval board, many technicians are tempted to skip this step, which is a huge mistake.

**Step 2.** Prioritize what is important in business

This stage begins with determining the manner in which performance within the company is measured. Each manager should be able to identify the performance of the company he leads, in each specific case and to know the strategic goals. Moreover, if the approval board was correctly constituted, this information may be provided to the members of other departments of the company. It should also be noted the priorities and weights of each objective (these will vary depending on the position of the interviewed person). Next, there will be drawn up a list of the operations that may impact, or being a support for each of the business goals. The list will be specific and will also depend on each purpose of the business.

The specialized literature identifies four general directions of the ICT operations objectives which will be mapped to the business objectives:

- Improving the efficiency of resources use;
- Decrease of failure rate;
- Improvement of the transitive operations;
- Enabling the business agility.

It has to be stressed that what matters to the individual members of the IT team is identical to what matters to the business.

**Step 3.** Giving more importance to key indicators compared to the prioritization of IT operations

At this stage, activities focus on the development of objectives list of the operation performed by IT and the list of all possible candidates for key performance indicators for each objective. Together with the approval board is passed through the list to highlight the importance of each candidate of key indicator in indicating the success or failure of each objective of prioritized IT operation. It should also be known the difficulty of measuring for each performance indicator taken into account for preparing the indicator system (candidate indicator). While there is concern for the ability of indicators to show the progress for reaching the objectives, the measurement difficulty may have practical implications when deciding on what should be firstly focused evaluation work.

**Step 4.** Gaining the consensus on a set of performance indicators

It works on the beginning in the board of approval and then in a wider board made up of people within the company, in order to obtain consensus on a set of indicators being analyzed. It is recommended to start with a set of 5-10 performance indicators. For the selection are used importance and priority criteria determined in the third stage.

**Step 5.** References and following up

It is created a reference for each performance indicator in the initial set. In this stage are validated the assumptions made in the previous steps. If seemed reasonable, is started the regular monitoring of the set of indicators. It is advisable to start with manual or semi-manual data collection and reporting indicators. If it is started directly with an automation tool there is a risk of being caught in what can or can not be automated, while the correct path is towards what is this automation. Transparency is an important problem of this process, so we need to make sure that anyone with a reasonable understanding capacity is able to understand how and why these metrics indicate the success or failure.

**Step 6.** Reevaluation and enlargement

The board of approval must regularly validate and analyze the results and propose new indicators, if this is required. Originally, the board meetings must be weekly, then monthly with weekly and daily reports of indicators. At this stage of the process may begin automating the data collection and reporting of indicators. After going through several cycles will be better understood what and how should be measured. Eventually, the automation allows to follow a number of indicators with a high degree of accuracy, and provides the possibility to supply to the organization a faster response loop.

## METRICS PROPOSED FOR EVALUATING THE IMPACT

Most metrics used to evaluate the information technology functions are classified according to the use functions. Such metrics for IT are divided into the following categories:

- Operational metrics: underlie an effective management and constitute effective indicators of what is executed;



- Metrics of verification or secondary: are used to verify if the completed work meets the standards and operated completed in accordance with the project;
- Performance or tertiary metrics: are indicators that refer to the performance criteria of the IT and provide information on efficiency and effectiveness.

The purpose of this research is to identify metrics intended for evaluating the impact of IT implementation in companies. The metrics that are relevant to the intended purpose must fall, according to the previous classification, in the category performance metrics.

The literature introduce several systems of metrics, which can be explained by the fact that they must be adequate to the specific nature of the organization, company etc. where the evaluation is carried out. Thus, in a study of Computer Aid Inc. company., a world leader in IT Metrics and Productivity, conducted by Spanos (2013) are identified 100 of IT metrics, divided into the following areas:

- I. Ensure the availability of the existing Processing Capabilities;
- II. Utilize Efficiently the Available Staff Resources;
- III. Timely Response to the Business Requests for New Features or Services;
- IV. Ensure the successful implementation of the system changes;
- V. Manage the cost of delivering the IT services and optimize value.

The metrics resulted following the research presented in this paper fall into the category of performance or tertiary metrics, after the function of use and belong to the the V. area, according to the above classification, and consists of the indicators presented as follows. Depending on the company objectives and strategy, all these metrics may become key performance indicators.

### **1. Endowing the labour with IT**

The calculation formula used in economy to calculate the technical endowment of labor is:

$$f = \frac{K}{L}, \text{ where}$$

- K is the capital invested;
- L, workforce expenses.

We define  $f_{IT} = \frac{K_{IT}}{L_{IT}}$ , representing the IT endowment of the workforce.

- $K_{IT}$  is the capital invested in IT;
- $L_{IT}$ , workforce expences in IT.

### **2. Efficiency of the funds invested in IT**

This metric is defined by the formula:

$$e = \frac{Q_{IT}}{f_{IT} \cdot L_{IT}}, \text{ where}$$

- $Q_{IT}$  is the volume of global production achieved due to IT (% of Q);
- $f_{IT}$  is the IT endowment of the workforce;
- $L_{IT}$  is the workforce expense in IT.

### 3. The amount of information entered into the organization by IT

Taking into account that the proposed indicator system evaluates the impact of IT use, the amount of information, data stored on the computing system will be measured in bytes, kilobytes, megabytes, etc.

### 4. Speed of response of the organization after the IT introduction

This metric can be defined either as the ratio of the amount of information and time of information dissemination or of system response or is simply the speed of information transmission through the transmission media.

## CONCLUSIONS

The paper highlights two ways of addressing the impact, namely: a priori, prediction, forecasting analysis and a posteriori, de facto, finding analysis. If is wanted an a priori evaluation, so a forecasting of the IT impact, before making an investment in this direction, the statistical methods are most appropriate. Rapid, even empirical methods are preferred in order to obtain an overview of what will happen, to capture particularly the trends. The impact evaluation of IT introduction in business, in order to be effective and reliable, must be carried out according to a well thought out plan which should be a part of the management strategy of the company.

The research proposes a methodology containing an algorithm that can be run through by identifying the specific elements of the organization and establishing the critical resources and risks. Metrics or performance indicators are not unique, being adequate for the purpose and objective of the business. Moreover, each of them expresses and defines a particular aspect of the company's performance and hence the impact of information technology.

Taking into account that the impact can be both positive and negative, the proposed indicators system evaluates the overall impact of IT in an organization, the total impact as an algebraic sum of impacts on components. It should be emphasized that no matter how beneficial is the effect of information technology, they are still a necessary but not sufficient condition for performance.

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